इंटरनेट मानक

Disclosure to Promote the Right To Information

Whereas the Parliament of India has set out to provide a practical regime of right to information for citizens to secure access to information under the control of public authorities, in order to promote transparency and accountability in the working of every public authority, and whereas the attached publication of the Bureau of Indian Standards is of particular interest to the public, particularly disadvantaged communities and those engaged in the pursuit of education and knowledge, the attached public safety standard is made available to promote the timely dissemination of this information in an accurate manner to the public.

"जानने का अधिकार, जीने का अधिकार"
Mazdoor Kisan Shakti Sangathan
"The Right to Information, The Right to Live"

"पुराने को छोड नये के तरफ"
Jawaharlal Nehru
"Step Out From the Old to the New"

IS/IEC 61058-1 (2000): Switches for appliances, Part 1: General requirements [ETD 14: Electrical Wiring Accessories]

"ज्ञान से एक नये भारत का निर्माण"
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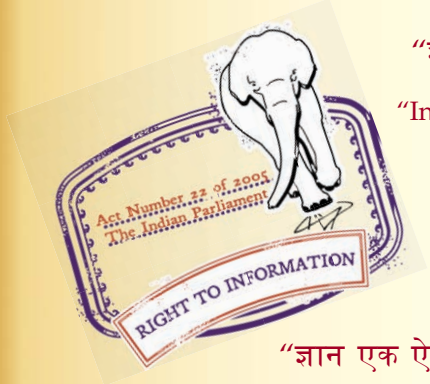

"ज्ञान एक ऐसा खजाना है जो कभी चुराया नहीं जा सकता है"
Bhartṛhari—Nītiśatakam
"Knowledge is such a treasure which cannot be stolen"

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भारतीय मानक

साधित्रों के लिए स्विच

भाग 1 सामान्य अपेक्षाएँ

Indian Standard

SWITCHES FOR APPLIANCES

PART 1 GENERAL REQUIREMENTS

ICS 29.120.40

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

July 2008

Price Rs 1210.00

The technical committee has reviewed the provisions of the following International Standards referred in this adopted standard and has decided that they are acceptable for use in conjunction with this standard:

International Standard	*Title*
IEC 60228A : 1982	Conductors of insulated cables — First supplement: Guide to the dimensional limits of circular conductors
IEC 60269-3-1 : 1994	Low-voltage fuses — Part 3-1: Supplementary requirements for fuses for use by unskilled persons (fuses mainly for household and similar applications) — Sections I to IV
IEC 60417-1 : 1998	Graphical symbols for use on equipment — Part 1: Overview and application
IEC 60695-2-1 (all sheets)	Fire hazard testing — Part 2-1: Test methods
IEC 60707 : 1999	Flammability of solid non-metallic materials when exposed to flame sources — List of methods
IEC 60730 (all parts)	Automatic electrical controls for household and similar use
IEC 60730-1 : 1999	Automatic electrical controls for household and similar use — Part 1: General requirements
IEC 60730-2-9 : 2000	Automatic electrical controls for household and similar use — Part 2-9: Particular requirements for temperature sensing controls
IEC 60760 : 1989	Flat, quick-connect terminations
IEC 60893-1 : 1987	Specification for Industrial rigid laminated sheets based on thermosetting resins for electrical purposes — Part 1: Definitions, designations and general requirements
IEC 60998-2-3 : 1991	Connecting devices for low-voltage circuits for household and similar purposes — Part 2-3: Particular requirements for connecting devices as separate entities with insulation piercing clamping units
IEC/TR2 61000-3-5 : 1994	Electromagnetic compatibility (EMC) — Part 3: Limits — Section 5: Limitation of voltage fluctuations and flicker in low-voltage power supply systems for equipment with rated current greater than 16 A
IEC 61000-4-3 : 1995	Electromagnetic compatibility (EMC) — Part 4: Testing and measurement techniques — Section 3 : Radiated, radio-frequency, electromagnetic field immunity test
IEC 61000-4-6 : 1996	Electromagnetic compatibility (EMC) — Part 4: Testing and measurement techniques — Section 6: Immunity to conducted disturbances, induced by radio-frequency fields
IEC 61032 : 1997	Protection of persons and equipment by enclosures — Probes for verification
IEC 61058-2-1 : 2000	Switches for appliances — Part 2-1: Particular requirements for cord switches
IEC 61058-2-4 : 2000	Switches for appliances — Part 2-4: Particular requirements for independently mounted switches
ISO 4046 : 1978	Paper, board, pulp and related terms — Vocabulary

Electrical Wiring Accessories Sectional Committee, ETD 14

NATIONAL FOREWORD

This Indian Standard (Part 1) which is identical with IEC 61058-1 : 2000 'Switches for appliances — Part 1: General requirements' incorporating Amendment No. 1 published in 2001, issued by the International Electrotechnical Commission (IEC) was adopted by the Bureau of Indian Standards on the recommendation of the Electrical Wiring Accessories Sectional Committee and approval of the Electrotechnical Division Council.

The text of IEC Standard has been approved as suitable for publication as an Indian Standard without deviations. Certain conventions are, however, not identical to those used in Indian Standards. Attention is particularly drawn to the following:

a) Wherever the words 'International Standard' appear referring to this standard, they should be read as 'Indian Standard'.

b) Comma (,) has been used as a decimal marker while in Indian Standards, the current practice is to use a point (.) as the decimal marker.

In this adopted standard, reference appears to certain International Standards for which Indian Standards also exist. The corresponding Indian Standards which are to be substituted in their respective places are listed below along with their degree of equivalence for the editions indicated:

International Standard	*Corresponding Indian Standard*	*Degree of Equivalence*
IEC 60034-1 : 1996 Rotating electrical machines — Part 1: Rating and performance	IS 4722 : 2001 Rotating electrical machines — Specification (*second revision*)	Technically Equivalent
IEC 60038 : 1983 IEC standard voltages	IS 12360 : 1988 Voltage bands for electrical installations including preferred voltages and frequency	do
IEC 60050 (151) : 1978 International Electrotechnical Vocabulary (IEV) — Chapter 151: Electrical and magnetic devices	IS 1885 (Part 74) : 1993 Electrotechnical vocabulary: Part 74 Electrical and magnetic devices	Identical
IEC 60050 (411) : 1973 International Electrotechnical Vocabulary (IEV) — Chapter 411: Rotating machinery	IS 1885 (Part 35) : 1993 Electrotechnical vocabulary: Part 35 Rotating machines (*first revision*)	Technically Equivalent
IEC 60050 (441) : 1984 International Electrotechnical Vocabulary (IEV) — Chapter 441: Switchgear, controlgear and fuses	IS 1885 (Part 17) : 1979 Electrotechnical vocabulary: Part 17 Switchgear and controlgear (*first revision*)	do

International Standard	*Corresponding Indian Standard*	*Degree of Equivalence*
IEC 60050 (826) : 1982 International Electrotechnical Vocabulary (IEV) — Chapter 826: Electrical installations of buildings	IS 732 : 1989 Code of practice for electrical wiring installations	Technically Equivalent
IEC 60060-1 : 1989 High-voltage techniques — Part 1: General definitions and test requirements	IS 2071 (Part 1) : 1993 High-voltage test techniques: Part 1 General definitions and test requirements (*second revision*)	Identical
IEC 60068-2-20 : 1979 Environmental testing — Part 2-20: Tests — Test T : Soldering	IS 9000 (Part XVIII/Sec 1 to 3) : 1981 Basic environmental testing procedures for electronic and electrical items: Part XVIII Solderability test	Technically Equivalent
IEC 60068-2-75 : 1997 Environmental testing — Part 2-75: Tests — Test Eh : Hammer tests	IS 9000 (Part 7/Sec 7) : 2006 Basic environmental testing procedures for electronic and electrical items: Part 7 Impact test, Section 7 Test Eh Hammer tests	Identical
IEC 60085 : 1984 Thermal evaluation and classification of electrical insulation	IS 1271 : 1985 Thermal evaluation and classification of electrical insulation (*first revision*)	Technically Equivalent
IEC 60112 : 1979 Method for determining the comparative and the proof tracking indices of solid insulating materials under moist conditions	IS 2824 : 1975 Method for determining the comparative tracking index of solid insulating materials under moist conditions (*first revision*)	do
IEC 60127-2 : 1989 Miniature fuses — Part 2: Cartridge, fuse-links	IS/IEC 60127 (Part 2) : 1989 Miniature fuses: Part 2 Cartridge fuse links — Specification	Identical
IEC 60228 : 1978 Conductors of insulated cables	IS 8130 : 1984 Conductors for insulated electric cables and flexible cords (*first revision*)	Technically Equivalent
IEC 60269-1 : 1986[1] Low-voltage fuses — Part 1: General requirements	IS 13703 (Part 1) : 1993 LV Fuses for voltages not exceeding 1 000 V ac or 1 500 V dc: Part 1 General requirements	Identical
IEC 60335-1 : 1991 Safety of household and similar electrical appliances — Part 1: General requirements	IS 302 (Part 1) : 1979 Safety of household and similar electrical appliances: Part 1 General requirements	Technically Equivalent

[1] Since revised in 1998.

International Standard	*Corresponding Indian Standard*	*Degree of Equivalence*
IEC 60364-4-41 : 1992 Electrical installations of buildings — Part 4: Protection for safety — Chapter 41: Protection against electric shock IEC 60364-4-442 : 1993 Electrical installations of buildings — Part 4: Protection for safety — Chapter 44: Protection against overvoltage — Section 442: Protection of low-voltage installations against faults betweeen high-voltage systems and earth IEC 60384-4-443 : 1995 Electrical installations of buildings — Part 4: Protection for safety — Chapter 44: Protection against overvoltages — Section 443: Protection against overvoltages of atmospheric origin or due to switching	IS 2309 : 1989 Code of practice for the protection of buildings and allied structures against lightning (*second revision*)	Technically Equivalent
IEC 60384-14 : 1993 Fixed capacitors for use in electronic equipment — Part 14: Sectional specification: Fixed capacitors for electromagnetic suppression and connection to the supply mains	IS QC 302400 : 1994 Fixed capacitors for use in electronics equipment sectional *specification for fixed capacitors for* electromagnetic interference suppression and connection to the supply mains	Identical
IEC 60529 :1989 Degree of protection provided by enclosures (IP code)	IS 12063 : 1987 Classification of degrees of protection provided by enclosures of electrical equipment	Technically Equivalent
IEC 60617-2:1983[1)] Graphical symbols for diagrams — Part 2: Symbol elements, qualifying symbols and other symbols having general application	IS 12032 (Part 2) : 1987 Graphical symbols for diagrams in the field of electrotechnology: Part 2 Symbols *elements, qualifying symbols and other* symbols having general application	Identical
IEC 60664-1 : 1992 Insulation coordination for equipment within low-voltage systems — Part 1: Principles, requirements and tests	IS 15382 (Part 1) : 2003 Insulation coordination for equipment within low-voltage systems: Part 1 Principles, requirements and tests	Technically Equivalent
IEC 60664-3 : 1992 Insulation coordination for equipment within low-voltage systems — Part 3: Use of coatings to achieve insulation coordination of printed board assemblies	IS 15382 (Part 3) : 2006 Insulation coordination for equipment within low-voltage systems: Part 3 Use of coating, potting or moulding for protection against pollution	do
IEC 60669-1 : 1998 Switches for household and similar fixed electrical installations — Part 1: General requirements	IS 3854 : 1997 Switches for domestic and similar purposes (*second revision*)	do
IEC 60691 : 1993 Thermal-links — Requirements and application guide	IS/IEC Pub 691 : 1993 Thermal links — Requirements and application guide (*first revision*)	Identical

[1)] *Since revised in 1996.*

International Standard	*Corresponding Indian Standard*	*Degree of Equivalence*
IEC 60738-1 : 1998 Thermistors directly heated positive step-function temperature efficient thermistors — Part 1: Generic specification	IS QC 440000 : 1994 Directly heated positive step-function temperature coefficient thermistors — Generic specification	Technically Equivalent
IEC 61000-3-2 : 1995 Electromagnetic compatibility (EMC) — Part 3: Limits — Section 2: Limits for harmonic current emissions (equipment input current ≤ 16 A per phase)	IS 14700 (Part 3/Sec 2) : 1999 Electromagnetic compatibility (EMC): Part 3 Limits, Section 2 Limits for harmonic current emissions (equipment input current ≤16 A per phase)	do
IEC 61000-3-3 : 1994 Electromagnetic compatibility (EMC) — Part 3: Limits — Section 3: Limitation of voltage fluctuations and flicker in low-voltage power supply systems for equipment with rated current ≤16 A	IS 14700 (Part 3/Sec 3) : 1999 Electromagnetic compatibility (EMC): Part 3 Limits, Section 3 Limitation of voltage fluctuations and flicker in low-voltage supply systems for equipment with rated current ≤16 A	Identical
IEC 61000-4-1 : 1992 Electromagnetic compatibility (EMC) — Part 4. Testing and measurement techniques — Section 1. Overview of immunity tests	IS 14700 (Part 4/Sec 1) : 1999 Electromagnetic compatibility (EMC): Part 4 Testing and measurement techniques, Section 1 Overview of immunity test	Technically Equivalent
IEC 61000-4-2 : 1995 Electromagnetic compatibility (EMC) - Part 4: Testing and measurement techniques — Section 2: Electrostatic discharge immunity test	IS 14700 (Part 4/Sec 2) : 1999 Electromagnetic compatibility (EMC): Part 4 Testing and measurement techniques, Section 2 Electrostatic discharge immunity test	do
IEC 61000-4-4 : 1995 Electromagnetic compatibility (EMC) — Part 4: Testing and measurement techniques — Section 4: Electrical fast transient/ burst immunity test	IS 14700 (Part 4/Sec 4) : 1999 Electromagnetic compatibility (EMC): Part 4 Testing and measurement techniques, Section 4 Electrical fast transient/burst Immunity test	do
ISO 1456 : 1988 Metallic coatings — Electrodeposited coatings of nickel plus chromium and of copper plus nickel plus chromium ISO 2081 : 1986 Metallic coatings — Electroplated coatings of zinc of iron or steel	IS 8435 : 1977 Methods for measurement of thickness of metallic coatings on plastics	do
ISO 2093 : 1986 Electroplated coatings of tin — Specification and test methods	IS 1359 : 1992 Electroplated coatings of tin (*third revision*)	do

Only the English language text has been retained while adopting it in this Indian Standard, and as such the page numbers given here are not the same as in the IEC Standard.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

SWITCHES FOR APPLIANCES

PART 1 GENERAL REQUIREMENTS

1 Scope

1.1 This International Standard applies to switches (mechanical or electronic) for appliances actuated by hand, by foot or by other human activity, to operate or control electrical appliances and other equipment for household or similar purposes with a rated voltage not exceeding 440 V and a rated current not exceeding 63 A.

These switches are intended to be operated by a person, via an actuating member or by actuating a sensing unit. The actuating member or sensing unit can be integral with or arranged separately, either physically or electrically, from the switch and may involve transmission of a signal, for example electrical, optical, acoustic or thermal, between the actuating member or sensing unit and the switch.

Switches which incorporate additional control functions governed by the switch function are within the scope of this standard.

This standard also covers the indirect actuation of the switch when the operation of the actuating member or sensing unit is provided by a remote control or a part of an appliance or equipment such as a door.

NOTE 1 Electronic switches may be combined with mechanical switches giving full disconnection or micro-disconnection.

NOTE 2 Electronic switches without a mechanical switch in the supply circuit provide only electronic disconnection. Therefore; the circuit on the load side is always considered to be live.

NOTE 3 For switches used in tropical climates, additional requirements may be necessary.

NOTE 4 Attention is drawn to the fact that the standards for appliances may contain additional or alternative requirements for switches.

NOTE 5 Throughout this standard, the word "appliance" means "appliance or equipment".

NOTE 6 This part of IEC 61058 is applicable when testing incorporated switches. When other types of switches for appliances are tested, this part is applicable together with the relevant IEC 61058-2.

This part may, however, be applied for other types of switches which are not mentioned in IEC 61058-2, provided that the electrical safety is not disregarded.

1.2 This standard applies to switches intended to be incorporated in, on or with an appliance.

1.3 This standard also applies to switches incorporating electronic devices.

1.4 This standard also applies to switches for appliances such as

- switches intended to be connected to a flexible cable (cord switches);

  NOTE In this document, the word "cable" means "cable or cord".
- switches integrated in an appliance (integrated switches);
- switches intended to be mounted apart from the appliance (independently mounted switches) other than those within the scope of IEC 60669-1;
- change-over selectors for which, however, particular requirements are given in IEC 61058-2.

IEC 60228:1978, *Conductors of insulated cables*

IEC 60228A:1982, *Conductors of insulated cables – First supplement: Guide to the dimensional limits of circular conductors*

IEC 60269-1:1998, *Low-voltage fuses – Part 1: General requirements*

IEC 60269-3-1:1994, *Low-voltage fuses – Part 3-1: Supplementary requirements for fuses for use by unskilled persons (fuses mainly for household and similar applications) – Sections I to IV*

IEC 60335-1:1991, *Safety of household and similar electrical appliances – Part 1: General requirements*
Amendment 1 (1994)

IEC 60335 (all parts 2), *Safety for household and similar electrical appliances*

IEC 60364-4-41:1992, *Electrical installations of buildings – Part 4: Protection for safety – Chapter 41: Protection against electric shock* [2)]
Amendment 1 (1996)
Amendment 2 (1999)

IEC 60364-4-442:1993, *Electrical installations of buildings – Part 4: Protection for safety – Chapter 44: Protection against overvoltage – Section 442: Protection of low-voltage installations against faults between high-voltage systems and earth* [3)]
Amendment 1 (1995)
Amendment 2 (1999)

IEC 60364-4-443:1995, *Electrical installations of buildings – Part 4: Protection for safety – Chapter 44: Protection against overvoltages – Section 443: Protection against overvoltages of atmospheric origin or due to switching* [4)]
Amendment 1 (1998)

IEC 60384-14:1993, *Fixed capacitors for use in electronic equipment – Part 14: Sectional specification: Fixed capacitors for electromagnetic suppression and connection to the supply mains*

IEC 60417-1:1998, *Graphical symbols for use on equipment – Part 1: Overview and application*

IEC 60529:1989, *Degree of protection provided by enclosures (IP code)*

IEC 60617-2:1996, *Graphical symbols for diagrams – Part 2: Symbol elements, qualifying symbols and other symbols having general application*

IEC 60664-1:1992, *Insulation coordination for equipment within low-voltage systems – Part 1: Principles, requirements and tests*

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2) There is a consolidated edition 3.2 (1999) that includes IEC 60364-4-41 and its amendments 1 (1996) and 2 (1999).

3) There is a consolidated edition 1.2 (1999) that includes IEC 60364-4-442 and its amendments 1 (1995) and 2 (1999).

4) There is a consolidated edition 3.2 (1999) that includes IEC 60364-4-443 and its amendment 1 (1998).

IEC 60664-3.1992, *Insulation coordination for equipment within low-voltage systems – Part 3. Use of coatings to achieve insulation coordination of printed board assemblies*

IEC 60669-1.1998, *Switches for household and similar fixed electrical installations – Part 1: General requirements*

IEC 60691 1993, *Thermal-links – Requirements and application guide*

IEC 60695-2-1 (all sheets), *Fire hazard testing – Part 2-1: Test methods*

IEC 60707 1999, *Flammability of solid non-metallic materials when exposed to flame sources – List of methods*

IEC 60730 (all parts), *Automatic electrical controls for household and similar use*

IEC 60730-1.1999, *Automatic electrical controls for household and similar use – Part 1 General requirements*

IEC 60730-2-9:2000, *Automatic electrical controls for household and similar use - Part 2-9 Particular requirements for temperature sensing controls*

IEC 60738-1 1998, *Thermistors directly heated positive step-function temperature efficient thermistors – Part 1 Generic specification*

IEC 60760 1989, *Flat, quick-connect terminations*

IEC 60893-1 1987, *Specification for industrial rigid laminated sheets based on thermosetting resins for electrical purposes – Part 1: Definitions, designations and general requirements*

IEC 60998-2-3.1991, *Connecting devices for low-voltage circuits for household and similar purposes – Part 2-3: Particular requirements for connecting devices as separate entities with insulation piercing clamping units*

IEC 61000 (all parts), *Electromagnetic compatibility (EMC)*

IEC 61000-3-2 1995, *Electromagnetic compatibility (EMC) – Part 3 Limits – Section 2 Limits for harmonic current emissions (equipment input current ≤16 A per phase)* [5]
Amendment 1 (1997)
Amendment 2 (1998)

IEC 61000-3-3:1994, *Electromagnetic compatibility (EMC) – Part 3: Limits – Section 3 Limitation of voltage fluctuations and flicker in low-voltage power supply systems for equipment with rated current ≤16 A*

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[5] There is a consolidated edition 1.2 (1998) that includes IEC 61000-3-2 and its amendments 1 (1997) and 2 (1998).

IEC/TR2 61000-3-5:1994, *Electromagnetic compatibility (EMC) – Part 3: Limits – Section 5: Limitation of voltage fluctuations and flicker in low-voltage power supply systems for equipment with rated current greater than 16 A*

IEC 61000-4-1:1992, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 1: Overview of immunity tests. Basic EMC publication*

IEC 61000-4-2:1995, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 2: Electrostatic discharge immunity test. Basic EMC publication* [6]
Amendment 1 (1998)

IEC 61000-4-3:1995, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 3: Radiated, radio-frequency, electromagnetic field immunity test* [7]
Amendment 1 (1998)

IEC 61000-4-4:1995, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 4: Electrical fast transient/burst immunity test. Basic EMC publication*

IEC 61000-4-6:1996, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 6: Immunity to conducted disturbances, induced by radio-frequency fields*

IEC 61000 4-11:1994, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 11: Voltage dips, short interruptions and voltage variations immunity tests*

IEC 61032:1997, *Protection of persons and equipment by enclosures – Probes for verification*

IEC 61058-2-1, *Switches for appliances – Part 2-1: Particular requirements for cord switches*

IEC 61058-2-4, *Switches for appliances – Part 2-4: Particular requirements for independently mounted switches*

ISO 1456:1988, *Metallic coatings – Electrodeposited coatings of nickel plus chromium and of copper plus nickel plus chromium*

ISO 2081:1986, *Metallic coatings – Electroplated coatings of zinc of iron or steel*

ISO 2093:1986, *Electroplated coatings of tin – Specification and test methods*

ISO 4046:1978, *Paper, board, pulp and related terms – Vocabulary*

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6) There is a consolidated edition 1.1 (1999) that includes IEC 61000-4-2 and its amendment 1 (1998).

7) There is a consolidated edition 1.1 (1998) that includes IEC 61000-4-3 and its amendment 1 (1998).

3 Definitions

For the purpose of this International Standard, the following definitions apply

3.1 General terms

3.1.1
mechanical switching device
a switching device designed to close and open one or more electric circuits by means of separable contacts
[IEV 441-14-02]

3.1.2
switch (mechanical)
a mechanical switching device capable of making, carrying and breaking currents under normal circuit conditions which may include specified operating overload conditions and also carrying for a specified time currents under specified abnormal circuit conditions such as those of short circuit

NOTE A switch may be capable of making but not breaking short-circuit currents

[IEV 441-14-10]

3.1.3
conductive part
part which is capable of conducting current although it may not necessarily be used for carrying service current
[IEV 441-11-09]

3.1.4
live part
a conductor or conductive part intended to be energized in normal use, including a neutral conductor, but, by convention, not a PEN conductor
[IEV 826-03-01]

3.1.5
pole of a switch
the part of the switch associated exclusively with one, electrically separated, conducting path of the switch

NOTE 1 Those parts that provide a means for mounting and operating all poles together are excluded from the definition of a pole

NOTE 2 A switch is called "single-pole" if it has only one pole. If it has more than one pole, it may be called "multipole" (two-pole, three-pole, etc) provided that the poles are coupled in such a manner as to operate together

3.1.6
clearance
the shortest distance in air between two conductive parts

3.1.7
creepage distance
the shortest distance along the surface of the insulation material between two conductive parts
[IEV 151-03-37]

3.1.8
detachable part
part which is removable without the use of a tool when the switch is mounted as in normal use

3.1.9
tool
screwdriver, coin, or any other object which may be used to operate a nut, a screw, or a similar part

3.1.10
special purpose tool
tool which is unlikely to be readily available in a normal household, for example, a key for a three-angle headed screw

NOTE Tools such as coins, screwdrivers and spanners designed to operate square or hexagonal nuts are not special purpose tools.

3.1.11
normal use
use of the switch for the purpose for which it was made and declared

3.1.12
ambient air temperature
the temperature or temperatures, determined under prescribed conditions, of the air surrounding the switch when mounted as declared by the manufacturer

3.1.13
proof tracking index (PTI)
the numerical value of the proof voltage in volts, at which a material withstands 50 drops of test solution without tracking

3.1.14
unique type reference
identification marking on a switch such that by quoting it in full to the switch manufacturer the electrical, mechanical, dimensional and functional parameters of the original switch can be unequivocally specified

3.1.15
common type reference
identification marking on a switch which does not require any further specific information additional to that provided by the marking requirements of this standard for selection, installation and use in accordance with this standard

3.1.16
cover or cover plate
part which is accessible when the switch is mounted as in normal use but which can be removed with the aid of a tool

3.1.17
signal indicator
device associated with a switch to indicate the circuit state visually

NOTE The device may or may not be controlled by the switch.

3.1.18
unprepared conductor
conductor which has been cut and the insulation of which has been removed for insertion into a clamping unit

NOTE A conductor the shape of which is arranged for introduction into a clamping unit or the strands of which are twisted to consolidate the end, is considered to be an unprepared conductor.

3.1.19
prepared conductor
conductor, the stripped end of which is fitted with an eyelet, a terminal end, a cable lug, etc.

3.1.20
base material
insulating material, supporting electronic circuits

3.1.21
printed board
a sized base material including holes, if any, and bearing at least one conductive pattern

3.1.22
printed board assembly
printed board with electrical and mechanical components and/or other printed boards attached to it, with all manufacturing processes, soldering, coating etc. completed

3.1.23
insulation distance
the shortest distance of a coated printed board between conductive parts located on the base material
See figure Q 1

3.1.24
polarity reversal
change of the terminals connected to the load by a switching action

3.1.25
semiconductor switching device
a switching device designed to make, carry, break and/or control the current in an electric circuit by means of the controlled conductivity of a semiconductor

3.1.26
electronic step-down convertor (convertor)
unit inserted between the supply and one or more tungsten-halogen or other filament lamps which serves to supply the lamp(s) with its (their) rated voltage, generally at high frequency. The unit may consist of one or more separate components

3.1.27
electronic switch
a device capable of making, carrying, breaking and/or controlling currents under normal circuit conditions which may include specified operating overload conditions and also carrying for a specified time currents under specified abnormal circuit conditions such as those of a short circuit. The device contains actuating members, actuating means and switching devices which may be mechanical or electronic. At least one of these must be electronic

3.1.28
duty
the statement of the load(s) to which the electronic switch is subjected, including, if applicable, making, controlling and breaking and including their durations and sequence in time
[IEV 411-21-07, modified]

3.1.29
duty-type
a continuous, short-time or periodic duty, comprising one or more loads remaining constant for the duration specified, or a non-periodic duty in which generally the load varies within the permissible operating range
[IEV 411-21-13, modified]

3.1.30
cyclic duration factor
the ratio between the period of loading, including making and breaking, and the duration of the duty cycle, expressed as a percentage
[IEV 411-21-10, modified]

3.1.31
protective impedance
an impedance connected between live parts and accessible conductive parts, of such value that the current, in normal use and under likely fault conditions in the electronic switch, is limited to a safe value; it is so constructed that the reliability is maintained throughout the life of the electronic switch

NOTE Details of the likely fault conditions, the safe current and the requirements for reliability are as given in this IEC standard.

3.2 Definitions relating to voltages, currents and wattage

NOTE Where the terms "voltage" and "current" are used, they imply the r.m.s. values unless otherwise specified.

3.2.1
rated voltage, current, frequency, wattage etc.
voltage, current, frequency, wattage etc. assigned to a switch by the manufacturer and to which operation and performance characteristics are referred

3.2.2
SELV
voltage which does not exceed 50 V a.c. r.m.s. or 120 V d.c. between conductors or between any conductor and earth in a circuit which is insulated from the supply mains

NOTE SELV is an unearthed extra low voltage (see IEC 60364-4-41).

3.2.3
over-current
a current exceeding the rated current
[IEV 441-11-06]

3.2.4
overload
operating conditions in an electrically undamaged circuit, which cause an over-current
[IEV 441-11-08]

3.2.5
short-circuit current
an over-current resulting from a short circuit due to a fault or an incorrect connection in an electric circuit
[IEV 441-11-07]

3.2.6
working voltage
highest r.m.s. value of the a.c. or d.c. voltage across any particular insulation which can occur when the switch is supplied at rated voltage

NOTE 1 Transients are disregarded.

NOTE 2 Both open-circuit conditions and normal operating conditions are taken into account.

3.2.7
overvoltage
any voltage having a peak value exceeding the corresponding peak value of maximum steady-state voltage at normal operating conditions

3.2.8
recurring peak voltage (U_{rp})
maximum peak value of periodic excursions of the voltage waveform resulting from distortion of an a.c. voltage or from a c. components superimposed on a d.c. voltage

NOTE Random overvoltages, for example due to occasional switching, are not considered to be recurring peak voltages.

3.2.9
temporary overvoltage
overvoltage at a power frequency of relatively long duration

3.2.9.1
short-term temporary overvoltage
temporary overvoltage with a duration not exceeding 5 s

NOTE The voltage values for short-term temporary overvoltage are higher than the voltage value for long-term temporary overvoltage (see 3.3 3 2.2 of IEC 60664-1)

3.2.9.2
long-term temporary overvoltage
temporary overvoltage with duration exceeding 5 s

3.2.10
impulse withstand voltage
highest peak value of impulse voltage of prescribed form and polarity which does not cause breakdown of insulation under specified conditions

3.2.11
overvoltage category
numeral defining a transient overvoltage condition

NOTE Overvoltage categories I, II and III are used (see annex K)

3.2.12
rated load
type of load assigned to the switch by the manufacturer

3.2.13
minimum load
load at which the electronic switch still operates correctly

3.2.14
thermal current
the continuous resistive current which, under the test conditions declared by the manufacturer (may also include the ambient temperature), generates, without forced cooling, the same heating as when the electronic switch is operating under specified ambient conditions at rated load, and/or duty type in the appliance with forced cooling present, if any

NOTE The concept "thermal current" allows simplified testing of the electronic switches, which in normal application have complex cooling conditions. The thermal current will always be determined by tests of the switch positioned on a table or in a simple test rig and comparative tests in the appliance in question. Consequently, the thermal current will normally be lower than the rated current This necessitates additional tests of the terminals, contacts, etc., in order to verify that they will be able to carry the rated current, when the electronic switch is mounted in the appliance. These additional tests are specified in clauses 16 and 17.

3.3 Definitions relating to the different types of switches

3.3.1
incorporated switch
switch intended to be incorporated in or fixed to an appliance, which however can be tested separately

3.3.2
integrated switch
switch, the function of which depends on its correct mounting and fixing in an appliance, and which can be tested only in combination with the relevant parts of that appliance

3.3.3
rotary switch
switch, the actuating member of which is a shaft or a spindle which has to be rotated to one or more indexed positions in order to achieve a change in contact state

NOTE The rotation of the actuating member may be unlimited or restricted in either direction.

3.3.4
lever switch
switch, the actuating member of which is a lever which has to be moved (tilted) to one or more indexed positions in order to achieve a change in contact state

3.3.5
rocker switch
switch, the actuating member of which is a low profile lever (rocker) which has to be tilted to one or more indexed positions in order to achieve a change in contact state

3.3.6
push-button switch
switch, the actuating member of which is a button which has to be pushed in order to achieve a change in contact state

NOTE The switch may be provided with one or more actuating members.

3.3.7
cord-operated switch
switch, the actuating member of which is a pull-cord which has to be pulled in order to achieve a change in contact state

3.3.8
push-pull switch
switch, the actuating member of which is a rod which has to be pulled or pushed to one or more indexed positions in order to achieve a change in contact state

3.3.9
biased switch
switch, the contacts and actuating member of which return to a predetermined position when the actuating member is released from the actuated position

3.4 Definitions relating to the operation of the switch

3.4.1
actuation
movement of the actuating member of the switch by hand, by foot, or by any other human activity

3.4.2
indirect actuation
movement of the actuating member of the switch provided indirectly by a part of an appliance into which the switch is incorporated or integrated, for example the door of an appliance

3.4.3
actuating member
part which is pulled, pushed, turned or otherwise moved to cause an operation

3.4.4
actuating means
any part which may be interposed between the actuating member and the contact mechanism in order to achieve contact operation

3.4.5
disconnection
interruption of an electrical circuit in a pole so as to provide insulation between the supply and those parts intended to be disconnected from the supply

3.4.6
micro disconnection
disconnection that provides correct functional performance by contact separation in the case of long-term temporary overvoltage

3.4.7
electronic disconnection
disconnection that provides a non-cycling correct functional performance by a semiconductor switching device in the case of long-term temporary overvoltage

3.4.8
full disconnection
disconnection that provides correct functional performance by contact separation in the case of short-term and long-term temporary overvoltage and impulse withstand voltage equivalent to basic insulation

3.4.9
all-pole disconnection
for single-phase a.c. appliances and for d.c. appliances a disconnection of both supply conductors substantially at the same time by a single switching action or, for appliances to be connected to more than two supply conductors, a disconnection of all supply conductors, except the earthed conductor substantially at the same time by a single switching action

3.4.10
operation
transfer of the moving contact(s) from one position to an adjacent position

3.4.11
operating cycle
succession of operations from one position to another and back to the first position through all other positions, if any
[IEV 441-16-02]

3.4.12
electronic actuating member
part, component or component group, for example an optical or acoustic sensing unit, which controls the actuating means or the switching device

3.4.13
electronic actuating means
part, component or component group, which controls electronically the switching device

3.4.14
abnormal conditions
conditions which may occur in the appliance or in the switch during normal operation

3.4.15
sensing unit
unit that is activated by any physical phenomenon or combination of those

3.5 Definitions relating to connections to the switch

3.5.1
external conductor
any cable, cord, core or conductor, a part of which is external to a switch, or to an appliance in or on which the switch is mounted. Such a conductor may be a supply lead or interconnecting cord between separate parts of an appliance or it may form part of the fixed wiring

3.5.2
integrated conductor
conductor which is either inside a switch or is used to permanently interconnect terminals or terminations of a switch

3.5.3
internal conductor
any cable, cord, core or conductor which is internal to an appliance, but is neither an external conductor nor an integrated conductor

3.5.4 Methods of attachment for cords

3.5.4.1
type X attachment
method of attachment such that the cord can be replaced without the aid of special purpose tools by a cord not requiring special preparation

3.5.4.2
type Y attachment
method of attachment such that the cord can only be replaced with the aid of special purpose tools normally available to the manufacturer or his agent

NOTE Such a method of attachment may be used either with common cords or with special cords.

3.5.4.3
type Z attachment
method of attachment such that the cord cannot be replaced without destroying the integrity of the switch

3.6 Definitions relating to terminals and terminations

3.6.1
terminal
conductive part of a switch provided for reusable electrical connections without the use of a special purpose tool or a special process

3.6.2
screw type terminal
terminal for the connection and/or interconnection and subsequent disconnection of one or more conductors the connection being made directly or indirectly by means of screws or nuts of any kind

3.6.3
pillar terminal
screw-type terminal in which the conductor(s) is (are) inserted into a hole or cavity, where it is (they are) clamped under the shank of the screw The clamping pressure may be applied directly by the shank of the screw, or through an intermediate clamping member to which pressure is applied by the shank of the screw

Examples of pillar terminals are shown in figure 1

3.6.4
screw terminal
screw-type terminal in which the conductor(s) is (are) clamped under the head of the screw The clamping pressure may be applied directly by the head of the screw or through an intermediate part such as a washer clamping plate or anti-spread device

Examples of screw terminals are shown in figure 2

3.6.5
stud terminal
screw-type terminal in which the conductor(s) is (are) clamped under a nut The clamping pressure may be applied directly by a suitably shaped nut or through an intermediate part, such as a washer clamping plate or anti-spread device

Examples of stud terminals are shown in figure 2

3.6.6
saddle terminal
screw-type terminal in which the conductor(s) is (are) clamped under a saddle by means of two or more screws or nuts

Examples of saddle terminals are shown in figure 3

3.6.7
lug terminal
screw-type terminal designed for clamping a cable lug or bar directly or indirectly by means of a screw or nut

Examples of lug terminals are shown in figure 4

3.6.8
mantle terminal
screw-type terminal in which the conductor(s) is (are) clamped against the base of a slot in a threaded stud by means of a nut The conductor is clamped against the bottom of the slot by a suitably shaped washer under the nut, by a central peg if the nut is a cap nut, or by equally effective means for transmitting the pressure from the nut to the conductor within the slot

Examples of mantle terminals are shown in figure 5

3.6.9
screwless terminal
terminal for the connection and/or interconnection and subsequent disconnection of one or more conductors, the connection being made, directly or indirectly, by means other than screws

NOTE The following terminals are not regarded as screwless terminals:

- terminals requiring fixing of special devices to the conductors before clamping them into the terminal, for example flat quick-connect terminations;
- terminals requiring wrapping of the conductors, for example those with wrapped joints;
- terminals providing direct contact to the conductors by means of edges or points penetrating the insulation.

Examples of screwless terminals are shown in figure 6

3.6.10
termination
connection between two or more conductive parts which can only be made or replaced by either a special purpose tool or a special process

3.6.11
flat quick-connect termination
electrical connection consisting of a tab and a female connector which can be readily inserted and withdrawn without use of tools

3.6.12
tab
portion of a flat quick-connect termination which is inserted into the female connector and is a part integral with the switch

Examples of tabs are shown in figure 7

3.6.13
female connector
portion of a flat quick-connect termination which is pushed onto the tab

An example of a female connector is shown in figure 8

3.6.14
solder terminal
conductive part of a switch provided to enable a termination to be made by means of solder

3.7 Definitions relating to insulation

3.7.1
basic insulation
insulation applied to live parts to provide basic protection against electric shock

3.7.2
supplementary insulation
independent insulation applied in addition to the basic insulation in order to provide protection against electric shock in the event of a failure of the basic insulation

3.7.3
double insulation
insulation comprising both basic insulation and supplementary insulation

3.7.4
reinforced insulation
single insulation system applied to live parts which provides a degree of protection against electric shock equivalent to double insulation

NOTE The term "insulation system" does not imply that the insulation must be one homogeneous piece It may comprise several layers which cannot be tested separately as supplementary or basic insulation.

3.7.5
functional insulation
insulation between live parts which is necessary only for the proper functioning of the switch

3.7.6
coating
solid insulating material laid on one or both sides of the surface of the printed board. Coating can be varnish, a dry film applied to the printed board or can be achieved by thermal deposition

NOTE Coating and base material of the printed board form an insulating system that may have properties similar to solid insulation

3.7.7
solid insulation
insulation material interposed between two conductive parts

NOTE In the case of a printed board assembly with a coating, solid insulation consists of the printed board itself as well as the coating In other cases, solid insulation consists of the encapsulating material

3.7.8
class 0 appliance
appliance in which protection against electric shock relies upon basic insulation; this implies that there are no means for the connection of accessible conductive parts, if any, to the protective conductor in the fixed wiring of the installation, reliance in the event of a failure of the basic insulation being placed upon the environment

3.7.9
class I appliance
appliance in which protection against electric shock does not rely on basic insulation only, but which includes an additional safety precaution in such a way that means are provided for the connection of conductive parts (which are not live parts) to the protective (earthing) conductor in the fixed wiring in such a way that these parts cannot become live in the event of a failure of the basic insulation

3.7.10
class II appliance
appliance in which protection against electric shock does not rely on basic insulation only, but in which additional safety precautions such as double insulation or reinforced insulation are provided, there being no provision for protective earthing or reliance upon installation conditions

NOTE A Class II appliance may be provided with means for maintaining the continuity of protective circuits, provided that such means are within the appliance and are insulated from accessible surfaces according to the requirements of Class II.

3.7.11
class III appliance
appliance in which protection against electric shock relies on supply at SELV and in which voltages higher than those of SELV are not generated

3.8 Definitions relating to pollution

3.8.1
pollution
any addition of foreign matter, solid, liquid, or gaseous that can result in a reduction of dielectric strength or surface resistivity of the insulation

3.8.2
micro-environment
immediate environment of the insulation which particularly influences the dimensioning of creepage distances

NOTE For self-produced pollution in arc chambers of switches, see annex L.

3.8.3
macro-environment
environment of the room or other location in which the switch is installed or used

3.8.4
pollution degree
numeral characterizing the expected pollution of the micro-environment

NOTE Pollution degrees 1, 2 and 3 are used (see 7.1.6 and annex L).

3.9 Definitions relating to manufacturers' tests

3.9.1
routine test
a test to which each individual switch for appliances is subjected during and/or after manufacture to ascertain whether it complies with the relevant requirements of this standard

[IEV 151-04-16, modified]

NOTE Routine tests are specified in annex R

3.9.2
sampling test
a test on a number of switches taken at random from a batch

[IEV 151-04-17, modified]

NOTE Sampling tests are specified in annex S

3.9.3
type test
a test of one or more switches made to a certain design to show that the design meets certain specifications

[IEV 151-04-15, modified]

4 General requirements

Switches shall be designed and constructed so that in normal use they function safely so as to cause no danger to persons or surroundings even in the event of such careless use as may occur in normal use, as specified in this part 1 of IEC 61058 and any appropriate part 2.

In general, compliance is checked by carrying out all the relevant tests.

5 General notes on tests

5.1 *Tests according to this standard are type tests*

5.2 *Unless otherwise specified in this standard, the specimens are tested as delivered, at an ambient temperature of 25 °C ± 10 °C The specimens are mounted as declared by the manufacturer, but, if significant, using the most unfavourable method if more than one method is declared.*

NOTE In case of doubt, the tests are made at an ambient temperature of 20 °C ± 5 °C

5.3 *Switches to be used with a non-detachable conductor are tested with the appropriate conductor connected.*

5.4 *If the switches are provided with tabs, for the tests according to clauses 16 and 17, new female connectors shall be used.*

The envelope dimensions of female connectors for flat quick-connect terminations used for tests shall be in accordance with figure 8.

NOTE A method of selection of female test connectors for flat quick-connect terminations is given in annex H

The female connectors shall be of a type suitable for the rated ambient temperature of the switch, and the crimped conductors shall be soldered or welded to the crimping area of the female connector, if any

5.5 *Unless otherwise specified the tests are carried out in the order of the clauses of this standard.*

The number of test specimens required and the relevant clauses are as follows

NOTE A survey of test specimens and related clauses is given in table 1

5.5.1 *Switches with the following ratings:*

- *d.c. only;*
- *both a.c and d.c ,*

the tests being carried out on d.c , provided that the d.c. voltage and current ratings are equal to, or greater than, the a c ratings.

For these ratings, the following specimens are used:

- *clauses 6 to 12 and 23: specimen No. 1;*
- *clauses 19 to 22: specimen No. 2; where clearances according to 20 1 are tested in accordance with annex M, three additional specimens are used;*
- *clauses 13 to 18:*
  - *with polarity marking: specimens Nos 3 to 5;*
  - *without polarity marking: specimens Nos. 3 to 5 with one polarity and specimens Nos. 6 to 8 with the opposite polarity,*
- *clause 25: three additional specimens.*

5.5.2 *Switches with the following ratings:*

- *a.c. only;*
- *both a.c. and d.c., but not meeting the provisions of 5.5.1.*

For these ratings, the following specimens are used:

- *clauses 6 to 12 and 23: specimen No. 1;*
- *clauses 19 to 22: specimen No. 2; where clearances according to 20.1 are tested in accordance with annex M, three additional specimens are used;*
- *clauses 13 to 18:*
  - *for a.c. rating: specimens Nos. 3 to 5;*
  - *for d.c. rating with marked polarity: specimens Nos. 6 to 8;*
  - *for d.c. rating without marked polarity: specimens Nos. 6 to 8 with one polarity and specimens Nos. 9 to 11 with the opposite polarity;*
- *clause 25: three additional specimens.*

5.5.3 *Switches with more than one rated voltage and/or rated current combination within one nature of supply*

For these ratings, the following specimens are used:

- *clauses 6 to 12 and 23: specimen No. 1;*
- *clauses 19 to 22: specimen No. 2; where clearances according to 20.1 are tested in accordance with annex M, three additional specimens are used;*
- *clauses 13 to 18:*
  - *for the combination with the highest current rating: specimens Nos. 3 to 5;*
  - *for the second combination: specimens Nos. 6 to 8;*
  - *for further combinations: specimens Nos. 9 to 11, etc.*

NOTE For switches having one rated current for more than one voltage rating, the switch shall be tested at the highest voltage rating for each type of load.

- *clause 25: three additional specimens.*

Table 1 – Test specimens

Clause		Specimens to be tested[1]	Notes
6	Rating	1	
7	Classification	1	
8	Marking and documentation	1	
9	Protection against electric shock	1	
10	Provision for earthing	1	
11	Terminals and terminations	1	2)
12	Construction	1	
13	Mechanism	3 4 5 6 7 8	3)
14	Protection against solid foreign objects, ingress of dust, water and humid conditions	3 4 5 6 7 8	3)
15	Insulation resistance and dielectric strength	3 4 5 6 7 8	2, 3)
16	Heating	3 4 5 6 7 8	
17	Endurance	3 4 5 6 7 8	3)
18	Mechanical strength	3 4 5	
19	Screws, current-carrying parts and connections	2	
20	Clearances, creepage distances solid, insulation and coatings of rigid printed board assemblies	2	4) 5)
21	Resistance to heat and fire	2	
22	Resistance to rusting	2	
23	Abnormal operation and fault conditions for electronic switches	1	
25	EMC requirements	three additional samples	

1) For the purpose of selection of female test connectors according to annex H, additional specimens may be necessary

2) Three additional new specimens may be required according to 11.1.1.3.4 of table 12, note 2)

3) The further specimens 9 to 11 etc., are tested in the same combination of clauses as specimens 6 to 8

4) Three additional new specimens may be required according to 20.1 for the test according to annex M

5) For testing coatings on printed boards according to 20.4, the following number of printed boards are needed.

- 13 specimens for type A coating;
- 17 specimens for type B coating

5.6 *Switches with a rated frequency are tested at that frequency. Switches without a rated frequency are tested at 50 Hz. Switches with a rated frequency range are tested at the most unfavourable frequency within that range.*

5.7 *If not more than one specimen fails during the tests of clauses 13 to 18 inclusive such as to cause non-compliance with the appropriate clause, the tests which caused the failure, and those preceding, which may have influenced the result of that test, are repeated on another set of identical specimens, all of which shall then comply with the repeated tests. No failure shall occur during the tests of clauses 6 to 12 inclusive and 19 to 22 inclusive.*

NOTE The applicant may submit, together with the first set of specimens, an additional set of specimens which may be needed in case one specimen fails.

The testing authorities will then, without further request, test the additional specimens and will only reject if a further failure occurs.

If the additional set of specimens is not submitted at the same time, a failure of one specimen will entail a rejection.

5.8 If it is necessary to have parts with double insulation or reinforced insulation in switches for Class 0 or Class I appliances, such parts are checked for compliance with the requirements specified for switches for Class II appliances.

Similarly, if it is necessary to have parts in switches operating at SELV, such parts are also checked for compliance with the requirements specified for switches for Class III appliances.

5.9 For the tests of this standard, actuation may be performed by test equipment. Tests at high speed, however, have to be performed according to 17.2.4.

For switches with electronic actuating members, actuation shall be performed according to the manufacturer's declarations.

5.10 As far as possible, signal indicators shall be tested together with the switches.

With the exception of the luminosity which can be disregarded, the lamp shall function unless otherwise specified. The test may be performed with test samples simulating the electrical, mechanical and thermal influences of the original indicator lamp. Replaceable indicator lamps may be replaced during the tests. Signal indicators, the function of which is independent from the function of the switch, are operated continuously.

The results of the tests for switches with indicator lamps shall be considered to apply to switches of equivalent construction without indicator lamps, or to indicator lamps of equivalent construction without the switching mechanism.

5.11 Switches intended to be operated from a specific supply, are tested with that specific supply.

5.12 In all tests, the measuring instruments or the measuring means shall be such as not to affect appreciably the quantity being measured.

5.13 For electronic switches, it may be necessary to disconnect or short-circuit electronic components for the purpose of the tests.

5.14 For the tests of 23.1.1.1, additional specimens may be necessary.

6 Rating

6.1 The maximum rated voltage is 440 V.

NOTE Preferred values are 50 V, 125 V, 230 V, 250 V, 400 V, 440 V.

6.2 Switches with signal indicators may have different rated voltages for the signal indicators.

6.3 The maximum rated current is 63 A.

Compliance with the requirements of 6.1 to 6.3 is checked by inspection of marking and documentation.

NOTE Preferred values are 1 A, 2 A, 4 A, 6 A, 10 A, 16 A, 20 A, 25 A, 40 A and 63 A.

7 Classification

7.1 Classification of switches

7.1.1 According to nature of supply:

7.1.1.1 – switches for a.c. only;

7.1.1.2 – switches for d c only;

7.1.1.3 – switches for both a.c and d.c.

7.1.2 According to type of load to be controlled by each circuit of the switch:

NOTE 1 A switch having more than one circuit need not have the same classification for each circuit.

NOTE 2 Annex F may be used for determining whether a particular switch rating is suitable for controlling the circuit in the actual application

7.1.2.1 – circuit for a substantially resistive load with a power factor of not less than 0,9,

7.1.2.2 – circuit for either a resistive load, a motor load with a power factor not less than 0 6, or a combination of both,

7.1.2.3 – circuit for a combination of resistive and capacitive a c loads,

7.1.2.4 – circuit for ordinary tungsten filament lamp load;

7.1.2.5 – circuit for a declared specific load;

7.1.2.6 – circuit for a current not exceeding 20 mA,

7.1.2.7 – circuit for specific lamp load;

7.1.2.8 – circuit for an inductive load with a power factor of not less than 0,6;

7.1.2.9 – circuit for specific load of motor with a locked rotor and with a power factor not less than 0,6

7.1.2.10 – minimum load for electronic switches

7.1.3 According to ambient temperature:

7.1.3.1 – switches at which the complete switch, including the actuating member, is intended to be used in an ambient temperature between a minimum value of 0 °C and a maximum value of 55 °C;

7.1.3.2 – switches at which the complete switch, including the actuating member, is intended to be used in an ambient temperature higher than 55 °C or lower than 0 °C, or both,

7.1.3.3 – switches intended to be used with the actuating member and other accessible parts in an ambient temperature between 0 °C and 55 °C, and the remainder of the switch in an ambient temperature higher than 55 °C:

- preferred values of maximum ambient temperature are 85 °C, 100 °C, 125 °C and 150 °C;
- preferred values of minimum ambient air temperature are –10 °C, –25 °C and –40 °C;
- values differing from these preferred values are allowed, as long as the values are multiples of 5 °C.

7.1.3.4 Electronic cord switches and electronic independently mounted switches are classified for a maximum ambient temperature of 35 °C.

NOTE The classification using the ambient air temperature 35 °C may also be used for other electronic switches under the provision that they are properly marked according to No. 3.2 in table 3.

7.1.3.4.1 – electronic cord switches and electronic independently mounted switches, in which the complete switch, including the actuating member, is intended to be used in an ambient air temperature between a minimum value of 0 °C and a maximum value of 35 °C.

NOTE The decrease of ambient temperature from 55 °C to 35 °C is caused by the fact that components of electronic switches have a larger heat dissipation than components of mechanical switches.

7.1.3.4.2 – electronic cord switches and electronic independently mounted switches, in which the complete switch including the actuating member is intended to be used in an ambient air temperature higher than 35 °C, or a minimum value lower than 0 °C, or both:

- preferred values of maximum ambient air temperature are 55 °C, 85 °C, 100 °C and 125 °C;
- preferred values of minimum ambient air temperature are –10 °C, – 25 °C and – 40 °C;
- values differing from these preferred values are allowed, as long as the values are multiples of 5 °C.

7.1.4 According to number of operating cycles:

7.1.4.1 – 100 000 operating cycles;

7.1.4.2 – 50 000 operating cycles;

7.1.4.3 – 25 000 operating cycles;

7.1.4.4 – 10 000 operating cycles;

7.1.4.5 – 6 000 operating cycles;

7.1.4.6 – 3 000 operating cycles;

7.1.4.7 – 1 000 operating cycles;

7.1.4.8 – 300 operating cycles.

7.1.5 According to degree of protection provided by the switch, when mounted as declared, as part of an appliance enclosure

7.1.5.1 Degree of protection against solid foreign objects (according to IEC 60529):

7.1.5.1.1 – non-protected against solid foreign objects (IP0X);

7.1.5.1.2 – protected against solid foreign objects of 50 mm diameter and greater (IP1X);

7.1.5.1.3 – protected against solid foreign objects of 12,5 mm diameter and greater (IP2X),

7.1.5.1.4 – protected against solid foreign objects of 2,5 mm diameter and greater (IP3X),

7.1.5.1.5 – protected against solid foreign objects of 1,0 mm diameter and greater (IP4X);

7.1.5.1.6 – dust-protected (IP5X);

7.1 5.1.7 – dust-tight (IP6X).

7.1.5.2 Degree of protection against ingress of water (according to IEC 60529):

7.1.5.2.1 – non-protected against ingress of water (IPX0);

7.1.5.2.2 – protected against vertically falling water drops (IPX1);

7.1.5.2.3 – protected against vertically falling water drops when enclosure tilted up to 15° (IPX2);

7.1.5.2.4 – protected against spraying water (IPX3);

7.1.5.2.5 – protected against splashing water (IPX4),

7.1.5.2.6 – protected against water jets (IPX5);

7.1.5.2.7 – protected against powerful water jets (IPX6);

7.1.5.2.8 – protected against the effects of temporary immersion in water (IPX7).

7.1.5.3 Degree of protection against electric shock for an incorporated switch for use in:

7.1.5.3.1 – a Class 0 appliance,

7.1.5.3.2 – a Class I appliance;

7.1.5.3.3 – a Class II appliance,

7.1.5.3.4 – a Class III appliance.

NOTE Switches for use in Class II appliances may be used without additional protection in all other appliances, *independently of class*

7.1.6 According to degree of pollution:

7.1.6.1 – pollution degree 1;

7.1.6.2 – pollution degree 2;

7.1.6.3 – pollution degree 3.

NOTE 1 Details for the pollution degrees are specified in annex L.

NOTE 2 A switch suitable for use in a particular situation may be used in a less polluted situation.

NOTE 3 A switch may be used in a more polluted situation than that for which it is designed if the appropriate additional protection is applied by the appliance.

7.1.7 According to the method of actuating the switch:

NOTE This classification is not restrictive. Push-button switches may have more than one push-button.

7.1.7.1 – rotary switch;

7.1.7.2 – lever switch;

7.1.7.3 – rocker switch;

7.1.7.4 – push-button switch;

7.1.7.5 – cord-operated switch;

7.1.7.6 – push-pull switch;

7.1.7.7 – electronic switches operated via a sensing unit (for example touching, approaching, turning, optical, acoustic, thermal or any other influences).

7.1.8 According to marking:

7.1.8.1 – switch with limited marking U.T. (Unique Type Reference, U.T.);

7.1.8.2 – switch with full marking C.T. (Common Type Reference, C.T.).

7.1.9 According to application level for resistance to heat and fire:

7.1.9.1 – level 1 switch;

7.1.9.2 – level 2 switch;

7.1.9.3 – level 3 switch.

NOTE For guidance concerning the levels, see clause 21.

7.1.10 According to the rated impulse withstand voltage:

7.1.10.1 – 330 V;

7.1.10.2 – 500 V;

7.1.10.3 – 800 V;

7.1.10.4 – 1 500 V;

7.1.10.5 – 2 500 V;

7.1.10.6 – 4 000 V.

NOTE The relation between rated impulse withstand voltage, rated voltage and overvoltage category is given in annex K.

7.1.11 **According to type of disconnection:**

7.1.11.1 – electronic disconnection;

7.1.11.2 – micro disconnection;

7.1.11.3 – full disconnection.

7.1.12 **According to the type of coating for rigid printed board assemblies:**

7.1.12.1 – type A coating;

7.1.12.2 – type B coating.

NOTE Explanations for type A and type B coating are given in annex P.

7.1.13 **According to type and/or connection of switches**

Details for types of switches and connections are specified in table 2

7.1.13.1 **One-way switches:**

7.1.13.1.1 – declared specific type and/or connection;

7.1.13.1.2 – single pole, single load (single-pole disconnection)

7.1.13.1.3 – double pole, single load (all-pole disconnection),

7.1.13.1.4 – double pole, double load (single-pole disconnection),

7.1.13.1.5 – double pole, double load (single-pole disconnection, load connected to opposite polarity);

7.1.13.1.6 – three pole, three loads, unswitched neutral (three-pole disconnection),

7.1.13.1.7 – four-pole, three-load switched neutral (four-pole disconnection);

7.1.13.1.8 – three pole, three load (three-pole disconnection)

7.1.13.2 **Two-way switches:**

7.1.13.2.1 – declared specific type and/or connection;

7.1.13.2.2 – single pole, single load (single-pole disconnection);

7.1.13.2.3 – single pole, double load (single-pole disconnection, for specific circuits and loads only);

7.1.13.2.4 – double pole, single load (all-pole disconnection);

7.1.13.2.5 – double pole, double load (all-pole disconnection, for specific circuits and loads only),

7.1.13.2.6 – double pole, single load with polarity reversal;

7.1.13.2.7 – double pole, four load (single-pole disconnection, load connected to opposite polarity, for specific circuits and loads only);

7.1.13.2.8 – double pole, double load (single-pole disconnection, load connected to opposite polarity);

7.1.13.2.9 – double pole, four load (single-pole disconnection for specific circuits and loads only).

7.1.13.3 Two-way switches with centre position for disconnection:

7.1.13.3.1 – declared specific type and/or connection;

7.1.13.3.2 – single pole, single load (single-pole disconnection);

7.1.13.3.3 – single pole, double load (single-pole disconnection),

7.1.13.3.4 – double pole, single load (all-pole disconnection);

7.1.13.3.5 – double pole, double load (all-pole disconnection);

7.1.13.3.6 – double pole, single load with polarity reversal (all-pole disconnection);

7.1.13.3.7 – double pole, four load (single-pole disconnection, load connected to opposite polarity);

7.1.13.3.8 – double pole, double load (single-pole disconnection, load connected to opposite polarity);

7.1.13.3.9 – double pole, four load (single-pole disconnection).

7.1.13.4 Multiway switches:

7.1.13.4.1 – the number of poles, type of connection and load as declared;

7.1.13.4.2 – single pole, four positions with polarity reversal (single-pole disconnection, for resistive load according to 7.1.2.1);

7.1.13.4.3 – double pole, four positions with polarity reversal (all-pole disconnection, for resistive load according to 7.1.2.1);

7.1.13.4.4 – double pole, five positions with polarity reversal (all-pole disconnection, for resistive load according to 7.1.2.1);

7.1.13.4.5 – double pole, seven positions with polarity reversal (all-pole disconnection, for resistive load according to 7.1.2.1).

NOTE Switches classified in 7.1.13.4.2 to 7.1.13.4.5 are designed for the step-wise increase or decrease of the resulting wattage of a combination of resistors (R_1 to R_3) according to table 2.

7.1.14 According to switching device for electronic switches:

7.1.14.1 – with semiconductor switching device;

7.1.14.2 – with mechanical switching device.

7.1.15 According to the condition of cooling for electronic switches:

7.1.15.1 – not requiring forced cooling;

7.1.15.2 – requiring forced cooling.

7.1.16 According to duty-type for electronic switches:

7.1.16.1 – continuous duty. Duty-type S1;

7.1.16.2 – short-time duty. Duty-type S2,

7.1.16.3 – intermittent periodic duty Duty-type S3.

NOTE 1 The different types of duty-type are illustrated in figures 14 to 16.

NOTE 2 The concept duty-type is taken from IEC 60034-1.

7.1.17 According to test conditions for electronic switches:

7.1.17.1 – functional test conditions with thermal current or maximum rated resistive current;

NOTE This test condition reflects the proper functioning of the switch This test does not simulate the actual load of the end application.

7.1.17.2 – simulated test conditions with type of load as classified in 7 1 2;

NOTE This test condition reflects the proper functioning of the switch. It also simulates all conditions of the end application

7.1.17.3 – specific test conditions of end application, i.e in or together with the appliance and under the cooling conditions of the appliance,

7.1.17.4 - test conditions according to duty-type

7.1.18 According to built-in protection for electronic switches:

7.1.18.1 – with built in protection;

7.1.18.2 – without built-in protection

7.2 Classification of terminals

7.2.1 – terminals intended for the connection of unprepared conductors and not requiring the use of any special purpose tool;

NOTE Twisting of a stranded conductor to consolidate the end is not considered as special preparation

7.2.2 – terminals intended for the connection of prepared conductors and/or requiring the use of a special purpose tool;

7.2.3 – terminals suitable for the connection of supply cables or cords with unprepared conductors and not requiring the use of any special purpose tool,

7.2.4 – terminals suitable for the connection of supply cables or cords with prepared conductors and/or requiring the use of a special purpose tool;

7.2.5 terminals suitable for the interconnection of two or more conductors,

7.2.6 – terminals intended for the connection of rigid, solid conductors,

7.2.7 – terminals intended for the connection of rigid, solid and stranded conductors;

7.2.8 – terminals intended for the connection of flexible conductors;

7.2.9 – terminals suitable for the connection of both flexible and rigid (solid and stranded) conductors;

7.2.10 – solder terminals intended for soldering by hand with a soldering iron;

7.2.11 – solder terminals intended for soldering with a solder bath;

7.2.12 – solder terminals with provisions for securing the conductor by mechanical means and providing circuit continuity by soldering;

7.2.13 – solder terminals without provisions for securing the conductor by mechanical means. The circuit continuity is ensured by soldering solely.

7.2.14 According to the resistance to soldering heat:

7.2.14.1 – solder terminals type 1;

7.2.14.2 – solder terminals type 2.

Table 2 – Type and connection of switches

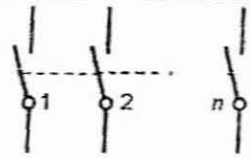
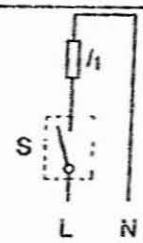
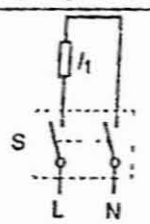
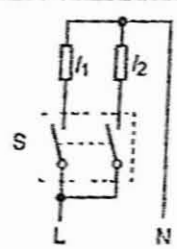
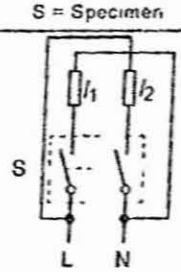
Classification	Code[1]	Type of switch	Type of connection	Test circuit[3]
		One-way switch		
7 1 13 1		Principle of one-way switches with one to *n* poles		
7 1 13.1 1	1.1	The number of poles, type of connection and load as declared		
7.1 13.1.2	1 2	Single pole	Single load (single-pole disconnection)	 S = Specimen
7 1 13 1 3	1 3	Double pole	Single load (all-pole disconnection)	 S = Specimen
7 1 13.1 4	1 4 [1 2]	Double pole	Double load (single-pole disconnection)	 S = Specimen
7 1 13 1 5	1 5 [1 2] [1.4]	Double pole	Double load (single-pole disconnection, load connected to opposite polarity)	 S = Specimen

Table 2 *(continued)*

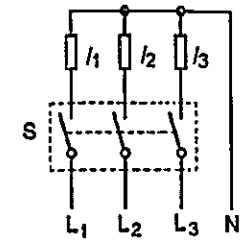
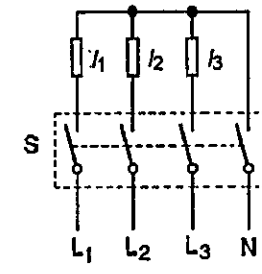
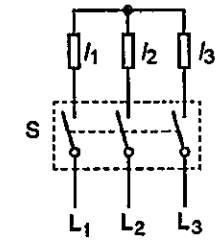
Classification	Code[1)]	Type of switch	Type of connection	Test circuit[3)]
7.1.13.1.6	1.6	Three pole	Three loads unswitched neutral, (three-pole disconnection)	 S = Specimen
7.1.13.1.7	1.7	Four pole	Three loads switched neutral (four-pole disconnection)	 S = Specimen
7.1.13.1.8	1.8	Three pole	Three loads (three-pole disconnection)	 S = Specimen

Table 2 *(continued)*

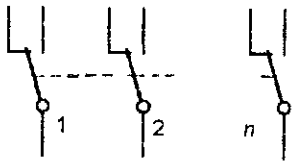
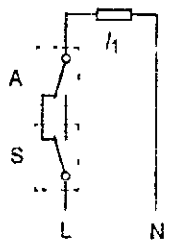
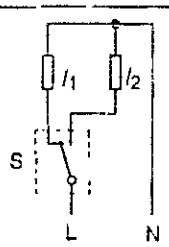
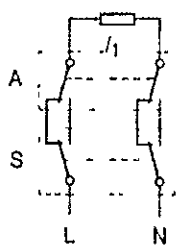
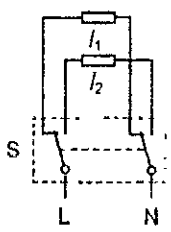
Classification	Code[1]	Type of switch	Type of connection	Test circuit[3]
		Two-way switch		
7 1.13.2		Principle of two-way switches with one to *n* poles		
7 1 13.2.1	2.1	The number of poles, type of connection and load as declared		
7 1.13 2.2	2 2 [1.2]	Single pole	Single load (single-pole disconnection)	 S = Specimen. A = Auxiliary switch
7 1 13 2 3 [2]	2.3	Single pole	Double load (single-pole disconnection)	 S = Specimen
7 1 13 2 4	2 4 [1.3]	Double pole	Single load (all-pole disconnection)	 S = Specimen. A = Auxiliary switch
7.1 13.2.5 [2]	2 5	Double pole	Double load (all-pole disconnection)	 S = Specimen

Table 2 (*continued*)

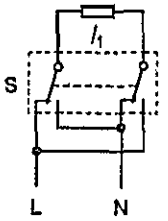
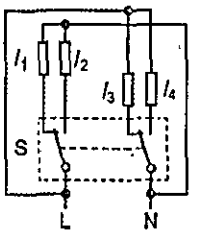
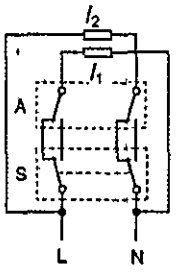
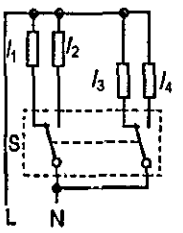
Classification	Code[1]	Type of switch	Type of connection	Test circuit[3]
7.1.13.2.6 [2]	2.6	Double pole	Single load with polarity reversal	 S = Specimen
7.1.13.2.7 [2]	2.7	Double pole	Four load (single-pole disconnection, load connected to opposite polarity)	 S = Specimen
7.1.13.2.8	2.8	Double pole	Double load (single-pole disconnection, load connected to opposite polarity)	 S = Specimen, A = Auxiliary switch
7.1.13.2.9 [2]	2.9	Double pole	Four load (single-pole disconnection)	 S = Specimen

Table 2 *(continued)*

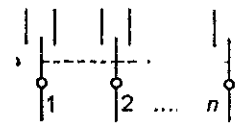
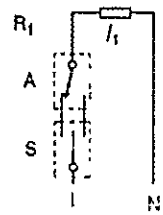
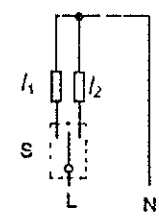
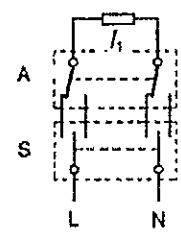
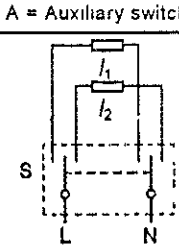
Classification	Code[1)]	Type of switch	Type of connection	Test circuit[3)]
		Two-way switch with centre position for disconnection		
7.1.13.3		Principle of two way switches with centre position and one to *n* poles		
7.1.13.3.1	3.1	The number of poles, type of connection and load as declared		
7.1.13.3.2	3.2	Single pole	Single load (single-pole disconnection)	 S = Specimen A = Auxiliary switch
7 1 13.3 3	3.3	Single pole	Double load (single-pole disconnection)	 S = Specimen
7 1 13.3.4	3 4	Double pole	Single load (all-pole disconnection)	 S = Specimen A = Auxiliary switch
7 1.13 3.5	3 5	Double pole	Double load (all-pole disconnection)	 S = Specimen

Table 2 (*continued*)

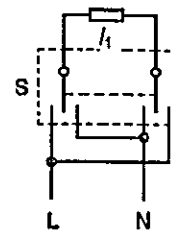
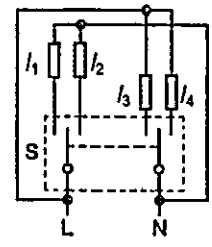
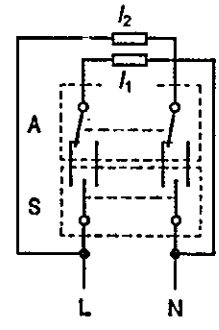
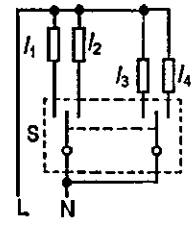
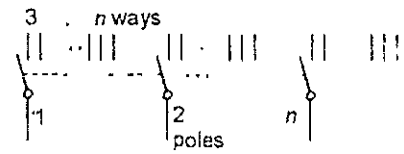
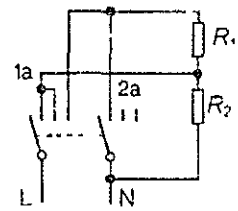
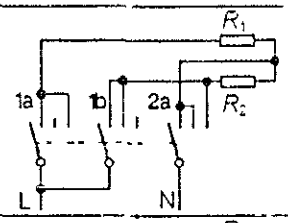
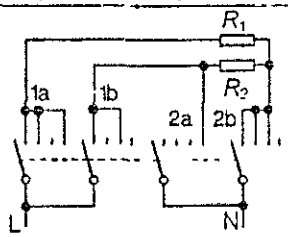
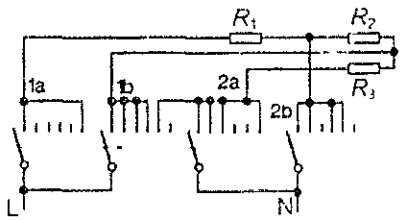
Classification	Code[1)]	Type of switch	Type of connection	Test circuit[3)]
7.1.13.3.6	3.6	Double pole	Single load with polarity reversal (all-pole disconnection)	 S = Specimen
7.1.13.3.7	3:7 [3.3]	Double pole	Four load (single-pole disconnection, load connected to opposite polarity)	 S = Specimen
7.1.13.3.8	3.8	Double pole	Double load (single-pole disconnection, load connected to opposite polarity)	 S = Specimen A = Auxiliary switch
7.1.13.3.9	3.9 [3.3]	Double pole	Four load (single-pole disconnection)	 S = Specimen A = Auxiliary switch

Table 2 *(continued)*

Classification	Code[1]	Type of switch	Type of connection	Test circuit[3]
		Multiway switches		
7.1 13.4		Principle of multiway switches with 3 to *n* ways and 1 to *n* poles		
7.1.13.4.1	4.1	The number of poles, type of connection and load as declared		
7.1.13 4.2	4.2	Single pole Four positions with polarity reversal (single-pole disconnection)		
7.1.13.4.3	4.3	Double pole Four positions with polarity reversal (all-pole disconnection)		
7 1 13 4 4	4.4	Double pole Five positions with polarity reversal (all-pole disconnection)		
7 1.13.4.5	4.5	Double pole Seven positions with polarity reversal (all-pole disconnection)		

1) For switches of the same basic design, the test is considered to cover the tests for the code of switch given in square brackets.

Switches are considered to be of the same basic design if

– all parts are the same, except those which have to be different because of the different poles and number of contact paths;

– the basic dimensions and mechanical constructions are the same;

– multipole switches are either composed of single-pole switches or build up from the same components as the single-pole switches, having the same overall dimensions per pole.

A separate test on a switch with momentary action (monostable switch) is not necessary, if it can be shown that the contact function is equivalent to a bistable switch of equivalent construction

2) For specific circuits and loads only.

3) The indication L and N only symbolizes the connection to the mains.

8 Marking and documentation

8.1 The switch manufacturer shall provide adequate information to ensure that

- the appliance manufacturer can select and install a switch;
- the end-user can use a switch as intended by the switch manufacturer;
- the corresponding tests can be performed in accordance with this standard.

This information shall be provided in one or more of the following ways, as detailed in table 3.

8.1.1 By Marking (Ma)

The information shall be provided by marking on the switch itself.

8.1.2 By Documentation (Do)

The information shall be provided by separate documentation, which may consist of a leaflet, a specification sheet, or a drawing, etc.

The content of the documentation shall be made available to the appliance manufacturer or end-user as appropriate in any suitable format.

NOTE 1 Where Ma/Do is indicated, the information can be provided by either marking or documentation.

NOTE 2 The format in which this information is presented is not within the scope of this standard.

Table 3 – Switch information

No.	Characteristic	Subclause	Means of information	
			Common type reference C.T.	Unique type reference U.T.
1	SWITCH IDENTIFICATION			
1 1	Manufacturer's name or trade mark		Ma	Ma
1.2	Type reference		Ma	Ma
2	SWITCH ENVIRONMENT/MOUNTING			
2.1	Degree of protection provided for the switch when mounted according to documentation (IP code of IEC 60529) NOTE Additional letters listed in IEC 60529 are not used	7.1 5 1 and 7 1 5 2	Do	Do
2.2	Degree of protection against electric shock, from outside an appliance	7.1.5 3	Do	Do
2.3	Method of mounting and actuating the switch and method of providing earthing if appropriate. The intended method(s) of mounting and the intended orientation(s) shall be declared The declared methods of mounting, together with any earthing terminal, are deemed to be the methods of earthing conductive parts unless otherwise specified	7 1 7 and 7 1 7 7	Do	Do
2.4	Pollution degree	7 1.6	Do	Do
3	TEMPERATURE			
3.1	Ambient temperature limits if different from 0 °C to 55 °C	7 1.3	Ma	Do
3.2	Ambient air temperature for electronic switches – cord switches and independently mounted switches if different from 0 °C to 35 °C – other switches, if different from 0 °C to 55 °C	7 1 3 4.1 or 7.1.3.4.2 7 1.3 2 or 7 1 3 3	Ma Ma	Do Do
4	ELECTRICAL LOAD/CONNECTION			
4.1	Rated voltage or rated voltage range	6 1	Ma	Do
4 2	Nature of supply if the switch is not intended for both a.c. and d c. or if the rating is different for a.c and d.c.	7 1 1	Ma	Do
4.3	Frequency or frequency range if different from 50 Hz or 50 Hz to 60 Hz		Ma	Do
4.4	For circuits of substantially resistive loads, the rated current of the rated load	7 1.2 1	Ma	Do
4.5	For circuits for resistive and motor load with a power factor not less than 0,6, the rated current and, for electronic switches, the minimum current (or power)	7.1.2.2	Ma/Do	Do
4.6	For circuits for resistive and capacitive load, the rated current and rated peak surge current and, for electronic switches, the minimum current (or power)	7 1 2.3	Ma/Do	Do
4.7	For circuits for tungsten filament lamp load, the rated current, and, for electronic switches, the minimum current (or power)	7.1.2 4	Ma/Do	Do
4.8	For circuits for declared specific loads, relevant details of the appliance to be controlled, or other specific load	7.1 2 5		Do
4 9	For switches for more than one circuit, the current applicable to each circuit and to each terminal. If these are different from each other, then it shall be made clear to which circuit or which terminal the information applies		Ma/Do	Do

Table 3 *(continued)*

No.	Characteristic	Subclause	Means of information	
			Common type reference C.T.	Unique type reference U.T.
4.10	Rated impulse withstand voltage	7.1.10	Do	Do
4.11	For electronic switches, the thermal current	8.4.7	Ma	Do
4.12	For electronic switches, the duty-type	7.1.16	Do	Do
4.13	For electronic switches, the ON/OFF-time for the relevant duty-type		Do	Do
4.14	Type and/or connection of switch	7.1.13	Do	Do
4.15	For circuits for specific lamp load, the rated current and the inrush current	7.1.2.7	Do	Do
4.16	For circuits for an inductive load with a power factor not less than 0,6	7.1.2.8	Ma	Do
4.17	For circuits for specific load of motor with a locked rotor and with a power factor not less than 0,6	7.1.2.9	Ma	Do
5	TERMINALS/CONDUCTORS			
5.1	All terminals shall be suitably identified, or their purpose self-evident, or the switch circuitry visually apparent. For terminals intended for the connection of supply conductors, the identification may take the form of a letter L, a number or of an arrow		Ma	Ma
5.2	Terminals for the connection of earthing conductors shall be marked with the earth symbol		Ma	Ma
5.3	Information for the connection of a conductor to the terminal if this needs prepared conductors or the use of a special-purpose tool	7.2	Do	Do
5.4	The method of connection and disconnection for screwless terminals		Do	Do
5.5	The type of conductor to be connected to the terminal	7.2.6 to 7.2.9	Do	Do
5.6	The suitability of the terminal for interconnection of two or more conductors	7.2.5	Do	Do
5.7	The type of solder terminal	7.2.10 to 7.2.14	Do	Do
5.8	The suitability of the terminal for connection of unprepared supply conductors	7.2.3	Do	Do
5.9	The suitability of the terminal for connection of prepared supply conductors	7.2.4	Do	Do
6	OPERATING CYCLES/SEQUENCE			
6.1	Number of operating cycles	7.1.4	Ma	Do
6.2	Operating sequence for switches with more than one circuit, if significant. For multi-circuit switches the operating sequence of the pairs of contacts shall be declared if this is of importance for the safety of the user. Contacts which "make before break" or "break before make" are examples		Do	Do
6.3	Forces applied to end stops or full travel of actuating member	17.2.3.4	Do	Do

Table 3 *(continued)*

No.	Characteristic	Subclause	Means of information	
			Common type reference C.T.	Unique type reference U.T.
7	SIGNAL INDICATORS			
7.1	Maximum power of tungsten filament signal lamps The marking shall be visible when replacing the lamp		Ma	Ma
7 2	Intended function or operation of the signal indicator		Do	Do
8	CIRCUIT DISCONNECTION			
8.1	Electronic disconnection	7 1 11.1	Ma	Do
8 2	Micro-disconnection	7.1.11 2	Ma	Do
8.3	Full disconnection	7.1 11.3	Do	Do
9	INSULATING MATERIALS			
9.1	Proof tracking index PTI	20.2	Do	Do
9.2	Level of glow-wire test	7 1.9	Do	Do
10	COOLING CONDITION			
10.1	Not requiring forced cooling	7.1 15.1	Do	Do
10 2	Requiring cooling	7 1 15.2	Do	Do
10.3	Direction of air for forced cooling		Do	Do
10 4	Speed of air for forced cooling		Do	Do
10 5	Thermal resistance of heat sink		Do	Do
10 6	Incoming temperature, density and other details of the air stream		Do	Do
11	PROTECTIVE DEVICE			
11 1	Rated current/fusing characteristic/breaking capacity of replaceable built-in protection	7.1 18 1	Ma	Do
11 2	Type/function of non-replaceable built-in protection	7 1 18.1	Do	Do
11 3	External protective device rated current, fusing characteristic, breaking capacity	7.1 18.2	Do	Do
12	TEST CONDITIONS	7 1 17	Do	Do

8.2 (vacant)

8.3 When symbols are used, they shall be as follows (see note 1):

Amperes ..... A
Volts V
Watts ..... W
Volt-amperes ..... VA
Alternating current (single-phase) ..... ~
or a.c.
or ~a.c.

Alternating current (three-phase) ..... 3~
or 3 a.c.
or 3~a.c.

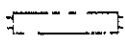
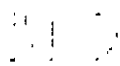
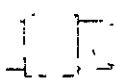
Alternating current (three-phase with neutral) ..... 3 N~
or 3 Na.c.
or 3 N~ a.c.

Direct current ..... ⎓
or d.c.
or ⎓ d.c.

Earth symbol (see note 2) ..... 

Protective earth symbol (see note 2) ..... 

Non-protected against solid foreign solid objects IP0X
Protected against solid foreign objects of 50 mm Ø and greater IP1X
Protected against solid foreign objects of 12 mm Ø and greater IP2X
Protected against solid foreign objects of 2,5 mm Ø and greater IP3X
Protected against solid foreign objects of 1,0 mm Ø and greater IP4X
Dust-protected IP5X
Dust-tight IP6X
Non-protected against ingress of water IPX0
Protected against vertically falling water drops IPX1
Protected against vertically falling water drops when enclosure tilted up to 15° IPX2
Protected against spraying water IPX3
Protected against splashing water IPX4
Protected against water jets IPX5
Protected against powerful water jets IPX6
Protected against the effects of temporary immersion of water IPX7
Ambient temperature limit(s) of switch ..... *T*
Frequency of supply ..... Hz
Number of operating cycles ..... See 8.7
Symbol for micro-disconnection ..... μ

Symbol for the "OFF" position or the direction of actuation to the "OFF" position (a circle)	○
Symbol for the "ON" position or the direction of actuation to the "ON" position (a straight bar)	|
Electronic disconnection	ε (Greek epsilon)
Type of load:	
Incandescent lamp load	
Fluorescent lamp load	
Transformer connection	
Iron core transformer with low-voltage tungsten filament lamp load	
Electronic step-down convertor with low-voltage tungsten filament lamp load	
Direction of air for forced cooling	
Speed of air for forced cooling	m/s
Thermal resistance of heat sink	K/W
Cyclic duration factor	%
Terminal for regulated load	

NOTE 1 The symbols used shall be in accordance with IEC 60417-1, IEC 60529 and IEC 60617-7.

NOTE 2 Preferably, the protective earth symbol in a circle should be used.

8.4 Information about rated current and rated voltage may be provided by using figures alone, the figure for the rated current preceding or being placed above that for the rated voltage and separated from it by a line.

8.4.1 For circuits for resistive load and for motor load, the rated current for motor load is placed between round brackets and immediately follows the rated current for resistive load. The symbol for the nature of the supply is placed before or after the current and voltage ratings.

Current, voltage and nature of supply may accordingly be indicated as follows:

16(3) A 250 V ~

or 16(3) / 250 ~

or $\frac{16(3)}{250}$ ~

8.4.2 For circuits for resistive load and for capacitive load, the marking of the peak surge current is separated from the marking of the rated current for resistive load by a stroke and follows immediately the rated current for resistive load. The symbol for the nature of the supply is placed after the current and voltage ratings.

Resistive current, peak surge current, voltage and nature of supply may be indicated accordingly as follows:

2/8 A 250 V ~

or $\frac{2/8}{250}$ ~

8.4.3 For circuits for resistive load and for tungsten filament lamp load, the peak surge current for tungsten filament lamp load is placed between square brackets and follows immediately the rated current for resistive load. The symbol for the nature of the supply is placed after the current and voltage ratings.

Resistive current, peak surge current, voltage and nature of supply may be indicated accordingly as follows:

6[3] A 250 V ~

or 6[3] / 250 ~

or $\frac{6[3]}{250}$ ~

In cases where the switch is rated for more than one type of load as specified in 7.1.2.2, 7.1.2.3 and 7.1.2.4, several different current figures given in appropriate brackets are permitted.

8.4.4 *Information concerning declared specific loads may be given by reference to drawings* or to types, for example:

"Electric motor, drawing number ....., parts list No. ....., made by.....", or "5 × 80 W fluorescent lamp load".

8.4.5 For circuits for inductive load according to 7.1.2.8, the rated current for inductive load is placed between double, pointed brackets. The symbol for the nature of the supply is placed before or after the current and voltage ratings.

Current, voltage and nature of supply may accordingly be indicated as follows:

"4 A" 250 V~

or "4" /250~

or $\frac{\text{"4"}}{250}$ ~

8.4.6 For circuits for specific load of motor (locked rotor) according to 7 1 2.9, the rated current of the motor shall be provided by adding the rated current of the motor (for example 3 A) as a second value within round brackets, separated by a stroke.

Current, voltage and nature of supply may accordingly be indicated as follows

6 (3/3) A 250 V~

or 6 (3/3) / 250~

or $\frac{6(3/3)}{250}$ ~

8.4.7 The thermal current, if applicable, as well as the test conditions for verifying the thermal current shall be specified.

Information concerning the thermal current shall be given, together with the maximum rated current and marked as the following example shows:

3 < 12 / 250 ~

If a minimum power is specified, it shall be indicated together with the maximum power and marked as the following example shows:

20 W / 100 W

NOTE In this example the number 3 indicates the thermal current

8.5 Information about rated ambient temperature shall be provided by indicating the lower temperature value preceding the letter "T", the higher temperature value following the letter "T" If no lower temperature value is given, the lower temperature value is 0 °C

25 T 85 (meaning –25 °C up to +85 °C)

T 85 (meaning 0 °C up to +85 °C)

If no information is given, the rated ambient temperature range is 0 °C up to 55 °C

8.5.1 For switches only partially suitable for a rated ambient temperature higher than 55 °C (according to 7.1.3.3), the information shall be provided as follows.

T 85/55 (meaning up to 85 °C for the switch body and up to 55 °C for the actuating member)

8.5.2 For switches only partially suitable for a rated ambient temperature higher than 55 °C or 35 °C (see 7.1.3.3 and 7.1.3.4), the information shall be provided as follows:

T 85/35 (meaning up to 85 °C for the switch body and up to 35 °C for the actuating member).

8.6 The symbol for Class II construction shall not be used for switches.

8.7 Information about the rated operating cycles shall be provided in a scientific manner by using symbol "E", indicating the exponent. For switches for 10 000 operating cycles according to 7.1.4.4, this information is not necessary:

1E3 = 1 000 25E3 = 25 000 1E5 = 100 000

8.8 Required marking on a switch shall preferably be on the body of the switch. It may, however, be placed on non-detachable parts but not on screws, removable washers or other parts which might be removed when connecting conductors and during installation of the switch. The marking for characteristics of any replaceable fuse incorporated in an electronic switch shall be placed on the fuse-holder or in the proximity of the fuse. The characteristics may be indicated by symbols (see IEC 60127).

For switches of small dimensions, the marking may be on different surfaces.

8.9 The required marking shall be legible and durable.

Compliance with the requirements of 8.1 to 8.8 is checked by inspection and by rubbing the marking by hand as follows:

a) *15 back-and-forth movements in about 15 s with a piece of cloth soaked with distilled water, followed by*

b) *15 back-and-forth movements in about 15 s with a piece of cloth soaked with petroleum spirit.*

During the tests, the soaked piece of cloth shall be pressed on the marking with a pressure of about 2 N/cm^2.

After these tests, the marking shall still be legible.

NOTE The petroleum spirit used is defined as an aliphatic solvent hexane with a content of aromatics of maximum 0,1 volume %, a kauributanol-value of 29, initial boiling point approximately 65 °C, dry point approximately 69 °C and specific gravity of 0,68.

8.10 For switches with their own enclosure and not intended to be incorporated in an appliance, the "OFF" position shall be clearly indicated. Switches with micro-disconnection or electronic disconnection shall not be marked with the symbol "O" for the "OFF" position. For switches where the marking of the switch position is impossible or leads to misunderstanding, for example rocker switches or push-button switches with more than one biased push-button, the direction of actuation(s) shall be marked. For switches having more than one actuating member, this marking shall indicate, for each of the actuating members, the effect achieved by its operation.

For push-button switches with a single button the OFF position need not be marked.

NOTE The symbol "O" is used only for full disconnection.

8.11 For electronic cord switches and independently mounted switches if there are more than two terminals, the load terminal shall be marked with an arrow pointing away from the terminal or with one of the symbols mentioned in 8.3 and any other terminals shall be marked corresponding to the installation instructions.

Unless the installation of the electronic switch is made clear by the markings of the terminals, a wiring diagram shall be provided with each switch.

9 Protection against electric shock

9.1 Switches shall be constructed so that there is adequate protection against contact with live parts in any position of use when the switch is mounted and operated as in normal use, and after any detachable parts have been removed, except lamps with caps.

For switches for Class II appliances, this requirement applies also to contact with metal parts separated from live parts by basic insulation only, or with basic insulation itself

NOTE For the purpose of this standard, metal-sensing surfaces which are connected to live parts by means of protective impedance (see 9.1.1) are considered to offer protection against electric shock

Compliance is checked by inspection and by the following test

a) the test is applied to those parts of the switch which are accessible when it is mounted in any position in accordance with the manufacturer's documentation, with any detachable parts, except lamps with caps, removed;

b) the jointed test finger of IEC 60529 is applied without force in every possible position Openings preventing the entry of the finger are further tested by means of a straight unjointed test finger of the same dimensions as the jointed test finger of IEC 60529, which is applied with a force of 20 N. If the unjointed test finger then enters the opening, the test is repeated with the jointed finger in the angled position. An electrical contact indicator is used to show contact,

c) in addition, openings in insulating material and in unearthed metal parts are tested by applying the test pin according to figure 13 without force in every possible position,

d) in case of doubt the tests are repeated under the conditions for the test of 16.2 2

It shall not be possible with either the standard test finger or the test pin to touch bare live parts.

For switches which have any parts of double insulation construction, it shall not be possible to touch with the standard test finger unearthed metal parts which are only separated from live parts by basic insulation, or by the basic insulation itself.

The insulating properties of lacquer, enamel, paper, cotton, oxide film on metal parts, beads and sealing compounds which soften in heat shall not be relied upon to give the required protection against contact with live parts.

Unless otherwise specified, parts connected to a SELV supply not exceeding 24 V are not considered to be live parts.

NOTE It is recommended to use a lamp for the indication of contact at a voltage not less than 40 V.

9.1.1 Accessible metal parts which are needed for the operation of an electronic switch (for example, sensing surfaces) may be connected to live parts by means of a protective impedance.

The protective impedance shall consist of resistors and/or capacitors and shall comply with one of the following:

a) at least two independent resistors of the same nominal value in series The resistors shall comply with the requirements given in 24.3;

b) at least two independent capacitors in series, of the same value. The capacitors shall comply with the requirements for class Y2 according to IEC 60384-14;

c) at least one resistor complying with 24.3 and one capacitor complying with the requirements for class Y2 according to IEC 60384-14 in series.

The removal of protective impedances, or their short-circuiting, shall be possible only by destruction of the electronic switch or by rendering the electronic switch obviously unusable.

Compliance is checked by inspection and by the tests in 24.3.

9.1.2 If a cover or cover-plate or a fuse can be removed without the use of a tool or if the instruction for use specifies that, for the purpose of maintenance, when replacing the fuse, covers and cover-plates fastened by means of a tool have to be removed, the protection against contact with live parts shall be assured even after removal of the cover or cover-plate.

NOTE If this requirement is achieved after a switch is built into an appliance, the switch itself does not have to comply with this requirement.

Compliance is checked with the standard test finger, test probe B according to IEC 61032.

9.1.3 If a switch is provided with a hole which is accessible to the user – when mounted as declared – for adjusting the setting of the switch and this hole is indicated as such, the adjustment shall not involve the risk of an electric shock.

Compliance is checked by applying a test pin according to IEC 61032, figure 3, test probe C, through the hole. The pin shall not touch live parts.

9.2 An actuating member shall be fixed adequately if the removal of the actuating member gives access to live parts. An actuating member is considered to be fixed adequately if access to live parts can be gained only by breaking or cutting or by dismantling with the aid of a special-purpose tool.

Compliance is checked by inspection and by applying the jointed test finger according to IEC 60529 without force.

9.3 For switches for appliances other than those of Class III, accessible parts of actuating members shall be of one of the following types:

a) insulating material;

b) metal separated from basic insulated parts by supplementary insulation;

c) metal separated from live parts by double or reinforced insulation;

d) for electronic switches, metal separated from live parts by protective impedances.

Compliance for items a) to c) is checked by inspection, measurement and test as appropriate.

Compliance for item d) is checked as follows:

The measurements are carried out between either a single accessible metal part or any combination of accessible metal parts and earth, through a non-inductive resistor of 2 kΩ at rated voltage (and rated load in ON-state), in ON- and OFF-state, and/or at lowest and highest setting value. During the measurements, each one of the resistors and all other components, if any, in the protective impedance, are short-circuited one at a time

The current must not exceed, in any measurement, 0,7 mA (peak value) for a c up to 1 kHz or 2 mA for d c.

For frequencies above 1 kHz, the limit of 0,7 mA is multiplied by the value of the frequency in kHz, but shall not exceed 70 mA.

9.4 Capacitors shall not be connected to unearthed metal parts which are accessible when the switch is mounted in accordance with the manufacturer's declarations. Metal casing of capacitors shall be separated by supplementary insulation from accessible unearthed metal parts, when the switch is mounted in accordance with the manufacturer's declarations

Compliance is checked by inspection and according to the requirements in clauses 15 and 20

10 Provision for earthing

10.1 Switches for Class II appliances shall have no provision for earthing the switch or parts thereof. Interconnections for maintaining the earthing circuit are permitted

Compliance is checked by inspection

10.2 Earthing terminals, earthing terminations and other earthing means shall not be connected electrically to any neutral terminal

Compliance is checked by inspection.

10.3 Accessible metal parts of switches for Class I appliances which may become live in the event of an insulation fault shall have provision for earthing

Compliance is checked by inspection

10.3.1 Parts separated from live parts by double insulation or reinforced insulation, and parts screened from live parts by metal parts connected to an earthing terminal, earthing termination or other earthing means are not regarded as likely to become live in the event of an insulation fault

10.3.2 Accessible metal parts of switches may be connected to earth through their fixing means, provided that provision is made for clean metallic surfaces at the connection points

10.4 The connection between an earthing terminal, earthing termination or other earthing means and parts required to be connected thereto shall be of low resistance.

Compliance is checked by the following test:

a) a current of 1,5 times the rated current but not less than 25 A, derived from an a.c. source, with a no-load voltage not exceeding 12 V, is passed between the earthing terminal, earthing termination, or other earthing means, and each of the parts in turn;

b) the voltage drop between the earthing terminal, earthing termination, or other earthing means, and each part connected thereto is measured when steady-state conditions have been achieved, and the resistance is calculated on the basis of the current and this voltage drop.

In no case shall the resistance exceed 50 mΩ.

NOTE Care has to be taken that the contact resistance between the tip of the measuring probe and the metal part under test does not influence the test results.

10.5 Earthing terminals of all types for unprepared conductors shall be of a size equal to, or larger than, that required for the corresponding current-carrying terminal. It shall not be possible to loosen the clamping means without the aid of a tool, and they shall be adequately locked against unintentional loosening.

Compliance is checked by inspection, by manual test and by the appropriate tests of clause 11.

10.5.1 In general, the designs commonly used for terminals according to 11.1.1 and 11.1.2 provide sufficient resilience to comply with the requirement for adequate locking against unintentional loosening.

10.5.2 If the switch is subjected to excessive vibration or temperature cycling, special provisions, such as the use of an adequately resilient part (for example, a pressure plate), may be necessary if pillar terminals are used.

10.6 Thread-cutting and thread-forming screws may be used to provide earthing continuity, provided that it is not necessary to disturb the connection in normal use and at least two screws are used for each connection.

Compliance is checked by inspection and during the tests of 19.2.

10.7 All parts of an earthing terminal shall be such that there is no risk of corrosion resulting from contact between those parts and the copper of the earthing conductor, or any other metal that is in contact with those parts.

10.8 The body of an earthing terminal shall be of brass or other metal no less resistant to corrosion, unless it is a part of the enclosure, when any screws or nuts shall be of brass, plated steel complying with 19.3, or other metal no less resistant to corrosion and rusting.

10.9 If the body of an earthing terminal is part of a frame or enclosure of aluminium or aluminium alloy, precautions shall be taken to avoid risk of corrosion resulting from contact between copper and aluminium or its alloys.

Compliance with the requirements of 10.7, 10.8 and 10.9 is checked by inspection, and in cases of doubt by analysis of the materials and their coatings or platings.

11 Terminals and terminations

NOTE A schematic diagram of families of terminals is given in annex G

11.1 Terminals for copper conductors

11.1.1 Terminals for unprepared copper conductors and not requiring the use of a special purpose tool

11.1.1.1 Common requirements

11.1.1.1.1 Terminals shall be such that connection is made by means of screws, nuts, springs, wedges, eccentrics, cones or equally effective means or methods, but without requiring a special-purpose tool for connection or disconnection

Compliance is checked by inspection

11.1.1.1.2 Terminals shall be fixed in such a way that they will not work loose when the clamping means are tightened or loosened

This requirement does not preclude floating terminals or terminals mounted on floating elements, such as those used in some stack-type switches provided their movement does not impair the correct operation of the switch.

Compliance is checked by fastening and loosening 10 times a conductor having the maximum cross-sectional area specified in table 4 for screw-type terminals the torque applied being the torque specified in table 20

11.1.1.1.3 Terminals shall be designed or placed so that a conductor cannot slip out while being connected or while the switch is being operated as intended

Compliance is checked by the following tests

a) terminals are fitted with conductors of maximum cross-sectional areas according to table 4 and the clamping means is fully tightened with the torque according to table 20 The test is repeated with the terminal fitted with conductors of minimum cross-sectional area according to table 4,

b) for terminals intended for the connection of two or more conductors the test is repeated with the terminal fitted with the declared numbers of conductors,

c) before insertion into the terminal, wires of rigid conductors are straightened and flexible conductors are twisted in one direction so that a uniform twist of one complete turn in a length of approximately 2 cm is obtained,

d) the conductor is inserted into the terminal over a length equal to the minimum distance prescribed or, if no distance is prescribed, until an end-stop is reached or until the conductor just projects from the far side of the terminal and in the position most likely to assist a strand to escape,

e) for flexible conductors the test is repeated using a new conductor which is twisted as prescribed above, but in the opposite direction

After the test, the conductor shall not have escaped into or through the gap between the clamping means and retaining device

NOTE The maximum diameters of the conductors according to IEC 60228A are given for information in table 5.

Table 4 – Resistive current carried by the terminal and related cross-sectional areas of terminals for unprepared conductors

Resistive current carried by the terminal A		*Flexible conductors*			
		Cross-sectional areas mm²			*Terminal size*
Over	*Up to and including*	*Minimum*	*Medium*	*Maximum*	
–	3		0,5	0,75	
3	6	0,5	0,75	1,0	0
6	10	0,75	1,0	1,5	1
10	16	1,0	1,5	2,5	2
16	25	1,5	2,5	4,0	4
25	32	2,5	4,0	6,0	5
32	40	4,0	6,0	10,0	6
40	63	6,0	10,0	16,0	7

Resistive current carried by the terminal A		*Rigid conductors*			
		Cross-sectional areas mm²			*Terminal size*
Over	*Up to and including*	*Minimum*	*Medium*	*Maximum*	
–	3	0,5	0,75	1,0	0
3	6	0,75	1,0	1,5	1
6	10	1,0	1,5	2,5	2
10	16	1,5	2,5	4,0	3
16	25	2,5	4,0	6,0	4
25	32	4,0	6,0	10,0	5
32	40	6,0	10,0	16,0	6
40	63	10,0	16,0	25,0	7

The different types of conductors are classified according to IEC 60228 as follows:

Rigid solid conductors	*Class 1*
Rigid stranded conductors	*Class 2*
Flexible conductors	*Classes 5 and 6*

Table 5 – Maximum diameters of circular copper conductors

Cross-sectional area	Rigid conductors in cables for fixed installation		Flexible conductors Classes 5 and 6* diameter
	Solid Class 1* diameter	Stranded Class 2* diameter	
mm²	mm	mm	mm
0,5	0 9	1 1	1 1
0,75	1,0	1 2	1 3
1,0	1,2	1 4	1 5
1,5	1,5	1 7	1 8
2,5	1,9	2 2	2 6
4,0	2,4	2 7	3,2
6,0	2,9	3 3	3 9
10,0	3 7	4 2	5 1
16,0	4,6	5 3	6 3
25,0	5,7	6 6	7 8

* According to IEC 60228

The different types of conductors are classified according to IEC 60228 as follows

Rigid solid conductors	Class 1
Rigid stranded conductors	Class 2
Flexible conductors	Classes 5 and 6

11.1.1.1.4 Terminals suitable for the connection of flexible conductors shall be located or shielded so that, if a wire of a flexible conductor escapes from a terminal when the conductors are fitted, there is no risk of contact between live parts and accessible metal parts, and for switches for Class II appliances, between live parts and metal parts separated from accessible metal parts by supplementary insulation only

Furthermore, there shall be no risk of short-circuiting those terminals which are electrically connected together by switch action

Compliance is checked by inspection and by the following test

a) at the end of a flexible conductor having the minimum cross-sectional area specified in table 4, the insulation is removed for a length of 8 mm One wire of the flexible conductor is left free and the remainder are fully inserted into the terminal and clamped,

b) the free wire is bent, without tearing the insulation back, in every possible direction, but without making sharp bends around barriers

The free wire of the flexible conductor shall not touch the relevant parts mentioned above Furthermore the free wire of a flexible conductor connected to an earthing terminal shall not touch any live part

11.1.1.1.5 Terminals shall be designed so that they clamp the conductor without undue damage to the conductor

Compliance is checked by inspection.

NOTE A test is under consideration

11.1.1.1.6 Terminals shall be designed so that the insertion of the conductor is prevented by a stop if further insertion may reduce creepage distances and/or clearances or influence the mechanism of the switch

Compliance is checked by inspection and during the tests of 11 1 1 1.3 and 11 1 1 1 4

11.1.1.2 Screw-type terminals for unprepared copper conductors

11.1.1.2.1 Screw-type terminals shall allow the connection of conductors having cross-sectional areas as specified in table 4.

NOTE Examples of screw-type terminals are given in figures 1, 2, 3, 4 and 5.

Compliance is checked by inspection, by measurement and by insertion of flexible and rigid conductors of cross-sectional areas according to table 4.

The conductors shall be able to enter into the terminal aperture without undue force to the designed depth of the terminal.

11.1.1.2.2 Screw-type terminals shall be designed so that they clamp the conductor reliably and between metal surfaces.

Compliance is checked by inspection and by the following test.

a) The terminals are fitted with conductors of the smallest and largest cross-sectional areas specified in table 4, the terminal screws being tightened with a torque equal to two-thirds of that specified in the appropriate column of table 20.

b) If the screw has a hexagonal head with a slot, the torque applied is equal to two-thirds of that specified in column III of table 20.

c) Each conductor is subjected to a pull of the force as given in table 6, the pull being applied without jerks, for 1 min, in the direction of the axis of the conductor space.

Table 6 – Pulling forces for screw-type terminals

Terminal size	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*
Pulling force N	*35*	*40*	*50*	*60*	*80*	*90*	*100*	*135*

d) If the terminal is declared as suitable for two or more conductors, the appropriate pull is applied consecutively to each conductor.

During the test, the conductor shall not move noticeably in the terminal.

11.1.1.2.3 Screws and nuts for clamping the conductors shall not serve to fix any other part, although they may hold the clamping part in place or prevent it from turning.

Compliance is checked by inspection and during the tests of 19.2.

11.1.1.3 Screwless terminals for unprepared copper conductors

11.1.1.3.1 Screwless terminals shall allow, according to their classification, the proper connection of conductors having cross-sectional areas as specified in table 4 up to and including 2,5 mm^2 of cross-sectional area for flexible conductors, and up to and including 4 mm^2 for rigid conductors.

It shall be obvious how the insertion and disconnection of the conductors are intended to be effected.

NOTE Examples of screwless terminals are shown in figure 6.

The intended disconnection of a conductor shall require an operation, other than a pull at the conductor, such that it can be effected manually with or without the help of a tool in normal use.

Openings for the use of a tool intended to assist the insertion or disconnection shall be clearly distinguishable from the opening for the conductor.

Compliance is checked by inspection, by measurement and by insertion of the appropriate flexible and/or rigid conductors of cross-sectional areas according to table 4.

The conductors shall be able to enter without undue force into the terminal aperture to the designed depth of the terminal.

11.1.1.3.2 Screwless terminals shall withstand the mechanical stress occurring in normal use

The conductor shall be clamped reliably and between metal surfaces, except that, for terminals intended to be used in circuits carrying a current not exceeding 0,2 A, one of the surfaces may be non-metallic.

Compliance is checked by the following test, which is carried out with uninsulated copper conductors, at first having the largest cross-sectional area, and then having the smallest cross-sectional area specified in table 4:

- *either rigid, five insertions and disconnections for solid conductors and one insertion and disconnection for stranded conductors,*
- *or flexible five insertions and disconnections,*
- *or rigid and flexible. if the terminal can accept both types of conductors, the tests are carried out with rigid and flexible conductors for the number of times indicated above*

a) The conductors are inserted and disconnected for the number of times indicated above using new conductors each time, except for the last time, when the conductors used for the last but one insertion are clamped at the same place For each insertion, the conductors are either pushed as far as possible into the terminal or shall be inserted so that adequate connection is obvious.

b) After each insertion, the conductor is twisted through 90° in an axial direction and then subjected to a pull of the force as specified in table 6; the pull is applied without jerks, for 1 min, in the direction of the axis of the conductor space

c) If the terminal is declared as suitable for two or more conductors, the appropriate pull is applied consecutively to each conductor

During the application of the pull, the conductor shall not come out of the terminal.

After these tests, neither the terminals nor the clamping means shall have worked loose.

NOTE A bending test for rigid conductors is under consideration.

11.1.1.3.3 Screwless terminals intended to be used for the interconnection of more than one conductor shall be designed so that

- after the insertion, the operation of the clamping means of one of the conductors is independent of the operation of the clamping means of the other conductor;
- during the disconnection, the conductors can be disconnected either simultaneously or separately

Compliance is checked by inspection and by tests with the appropriate conductors in any combination.

11.1.1.3.4 Screwless terminals shall withstand the thermal stress occurring in normal use.

When the clamping means of the screwless terminal does not form part of the conductive path through the switch, compliance is checked during the tests of clause 17.

When the switch has a rated number of operating cycles below 10 000, or when the clamping means of the screwless terminal forms part of the conductive path through the switch, compliance is checked by the following thermal endurance test.

For the purpose of this test for switches classified according to 7.1.3.2 and 7.1.3.3, three separate new switches are mounted and connected as declared and are placed in a heating cabinet which is initially kept at a temperature of 25 °C ± 2 °C.

Switches classified according to 7.1.3.3 are mounted as in normal use.

For switches classified according to 7.1.3.1, three separate new switches are kept at 25 °C ± 10 °C throughout this test and only submitted to the current cycles.

During the test, the maximum rated current is passed through the switches.

Then the switches are subjected to 192 test cycles, each cycle having a duration of approximately 1 h, as follows:

a) the temperature in the cabinet is raised in approximately 20 min to the maximum ambient temperature. It is maintained within ±5 °C of this value for approximately 10 min;

b) the switches are then allowed to cool down in approximately 20 min to a temperature of approximately 30 °C, forced air cooling being allowed. They are kept at this temperature for approximately 10 min. During the cooling-down period, no current is flowing through the specimens;

c) the temperature in the heating cabinet shall be measured at a distance of at least 50 mm from the specimen assemblies.

After the 192 test cycles, the temperature rise at the terminals shall not exceed 55 K when measured in accordance with 16.2.2 except that the temperature-rise test at the terminals is carried out at rated current and in an ambient temperature of 25 °C ± 10 °C.

If one of the terminals does not comply with the test, the test is repeated using a second set of specimens all of which shall then comply.

11.1.1.4 Insulation piercing terminals for insulated unprepared copper conductors

NOTE Requirements and tests based on IEC 60998-2-3 are under consideration.

11.1.2 Terminals for prepared copper conductors and/or requiring the use of a special purpose tool

11.1.2.1 Common requirements

11.1.2.1.1 Terminals shall be suitable for their purpose when the connection is made as declared.

Compliance is checked by inspection and during the tests of clauses 16 and 19.

11.1.2.1.2 Terminals shall allow the connection of conductors having cross-sectional areas as declared

Compliance is checked by inspection and by fitting conductors of the declared types and cross-sectional areas

11.1.2.1.3 Terminals shall be designed so that they make connection reliably between metal surfaces and without undue damage to the conductor

Compliance is checked by inspection and during the tests of clauses 16 and 19. The results are only taken into account when the conductor is clamped directly in the terminal and/or when the precise method of special preparation is declared. In all other cases, the reliability is determined by the end-application.

11.1.2.1.4 Terminals shall be designed so that the insertion of the conductor is limited by a stop, if further insertion may reduce creepage distances and/or clearances or influence the mechanism of the switch

Compliance is checked by inspection and during the tests of 11.1.2.1.2 and 11.1.2.1.3.

11.1.2.2 Screw-type terminals for prepared copper conductors

No further specific requirements

11.1.2.3 Screwless terminals for prepared copper conductors

11.1.2.3.1 Screwless terminals shall clamp the conductor between metal surfaces, except that, for terminals intended to be used in circuits carrying a current not exceeding 0,2 A, one of the surfaces may be non-metallic

Compliance is checked by inspection.

11.1.2.3.2 Screwless terminals shall withstand the thermal stress occurring in normal use

Compliance is checked by the appropriate test according to 11.1.1.3.4

11.1.2.4 Tabs of flat quick-connect terminations

11.1.2.4.1 Tabs forming part of a switch shall comply with the dimensions according to figure 7

Compliance is checked by measurement

Tabs with dimensions other than those shown in figure 7 are allowed only if the dimensions and shapes are so different as to prevent any mating with the female connector shown in figure 8 and prescribed in IEC 60760.

11.1.2.4.2 Tabs may have an optional detent for latching. Round dimple detents, rectangular dimple detents and hole detents shall be located in the area "EF" along the centre line of the tab as indicated in figure 7

11.1.2.4.3 Provisions for non-reversible connections may be located in the area "EF" along the centre line of the tab, as indicated in figure 7

11.1.2.4.4 The material and plating of tabs shall be appropriate to the maximum temperature of the tab as specified in table 7.

Table 7 – Material and plating for tabs

Material and plating of tabs	Maximum temperature of the tab °C
Bare copper	155
Bare brass	210
Tin plated copper and copper alloys	160
Nickel plated copper and copper alloys	185
Silver plated copper and copper alloys	205
Nickel plated steel	400
Stainless steel	400
NOTE Materials or platings other than those specified may be used, provided their electrical and mechanical characteristics are no less reliable, particularly with regard to resistance to corrosion and mechanical strength.	

11.1.2.4.5 Tabs shall allow the application and withdrawal of female connectors without damage to the switch such as to impair compliance with this standard.

Compliance is checked by applying axial forces without jerks equal to those specified in table 8. No significant displacement or damage shall occur.

Table 8 – Push and pull forces for tabs

Tab size[3]	*Push* [1] *N*	*Pull*[1] *N*
2,8	*64*	*58*
4,8	*80*	*98* [2]
6,3	*96*	*88*
9,5	*120*	*110*

1) The forces are the maximum allowed for a single tab.

2) The value is higher than that of the next largest size of tab according to the actual design of female connectors of IEC 60760.

3) See figure 7 for tab sizes.

11.1.2.4.6 Tabs shall be adequately spaced to allow the connection of the appropriate uninsulated female connectors.

Compliance is checked by applying an appropriate female connector to each tab in the most onerous orientation; during this operation, no strain or distortion shall occur to any of the tabs or to their adjacent parts, nor shall the creepage distances or clearances be reduced to values less than those specified in clause 20.

NOTE 1 For tabs complying with figure 7, an appropriate female connector is that shown in figure 8.

NOTE 2 Requirements for insulated female connectors are under consideration.

11.1.2.5 Insulation piercing terminals for prepared insulated copper conductors

NOTE Requirements and tests are under consideration

11.1.2.6 Solder terminals

11.1.2.6.1 Solder terminals shall have sufficient solderability

Compliance is checked by applying the relevant tests according to IEC 60068-2-20

For the purpose of test Ta, the conditions of table 9 apply

Compliance with 11 1 2.6.2 for solder terminals with normal resistance to soldering heat shall be checked immediately after this test

Table 9 – Test conditions for Ta

Clause of IEC 60068-2-20	*Condition*
4 3 2 / 4 8.3	*No degreasing is required*
4 4	*No initial measurements*
4 5	*No ageing*
4 6 / 4 7	*Test method 1 Solder bath at 235 °C, or test method 2 Soldering iron at 350 °C is applied, depending on the classification of terminals as specified in 7 2 10 and 7 2 11*
4 6 2 /4 8 2 3	*Non-activated flux*
4 6 3 /4.9.2	*Immersion time 2 s to 3 s*
4 6.3	*No thermal screen used*
4.7 3	*Soldering iron size "B"*
4.7 3	*No thermal heat sink used*
4 7 3	*Application time of soldering iron, 2 s to 3 s*
4.8.4	*Soldering time 2 s max*
4 9	*No de-wetting*
4.10	*Final measurement temperature rise according to clause 16*

The dipped surface shall be covered with a smooth and bright solder coating with no more than small amounts of scattered imperfections such as pin-holes or unwetted or de wetted areas These imperfections shall not be concentrated in one area

11.1.2.6.2 Solder terminals shall have sufficient resistance to soldering heat

For solder terminals with resistance to soldering heat type 1 (classified according to 7 2 14 1), compliance is checked during the tests of 11 1 2.6.1

After the tests, the solder terminals shall not have worked loose, or have been displaced in a manner impairing their further use, and they shall still comply with the requirements of clause 20

For solder terminals with resistance to soldering heat type 2 (classified according to 7 2 14 2), compliance is checked by applying the relevant tests according to IEC 60068-2-20

For the purpose of test Tb, the conditions of table 10 apply

Table 10 – Test conditions for Tb

Clause of IEC 60068-2-20	*Condition*
5.3	*No initial measurements*
5.4 / 5.5	*Test method 1A: Solder bath at 260 °C, or test method 2: Soldering iron at 350 °C, is applied, depending on the declared type of solder terminal*
5.4.3	*Immersion time: 5 s ± 1 s*
5.4.3	*No thermal screen used*
5.6.1	*Soldering iron size "B"*
5.6.3	*No thermal heat sink used*
5.6.3	*Application time of soldering iron: 5 s ± 1 s*

After the tests, the solder terminals shall not have worked loose, or have been displaced in a manner impairing their further use, and they shall still comply with the requirements of clause 20.

11.1.2.6.3 Solder terminals classified according to 7.2.12 shall be provided with means for mechanically securing the conductor in position independently of the solder.

Such means may be provided by

- a hole suitable for hooking-in the conductor;
- by shaping the edges of the terminal to allow the conductor to be wrapped around the terminal before soldering;
- a clamping means adjacent to the solder connection.

11.1.3 Additional requirements for terminals for supply connection and connection of external cords

11.1.3.1 Each terminal shall be located near to its corresponding terminal of different polarity, and to the earthing terminal, if any, unless there is a sound technical reason for the contrary.

NOTE According to IEC 60335-1, power supply cords are assembled with the appliance by one of the following methods of attachment:

- type X attachment;
- type Y attachment;
- type Z attachment.

12 Construction

12.1 Constructional requirements relating to protection against electric shock

12.1.1 When double insulation is employed the design shall be such that the basic insulation and the supplementary insulation can be tested separately, unless compliance with regard to the properties of both insulations is provided in another way.

Compliance is checked by inspection.

a) If the basic and the supplementary insulation cannot be tested separately, or if compliance with regard to the properties of both insulations cannot be obtained in another way, the insulation is considered to be reinforced insulation.

b) Specially prepared specimens, or specimens of the insulating parts, are considered to be ways of providing means of determining compliance.

12.1.2 Switches shall be designed so that creepage distances and clearances cannot be reduced, as a result of wear, below the values specified in clause 20. They shall be constructed so that if any conductive part of the switch becomes loose and moves out of position, it cannot get so disposed in normal use that creepage distances or clearances across supplementary insulation or reinforced insulation are reduced

Compliance is checked by inspection, by measurement and by manual test

For the purpose of this test:

- *it is not to be expected that two independent fixings will become loose at the same time;*
- *parts fixed by means of screws or nuts provided with locking washers are regarded as not liable to become loose, provided that these screws or nuts are not required to be removed during user maintenance or servicing,*
- *springs and spring parts are not regarded as being liable to become loose or fall out of position if they do not do so during the tests of clauses 18 and 19*

12.1.3 Integrated conductors shall be rigid, fixed, or insulated so that in normal use creepage distances and clearances cannot be reduced below the values specified in clause 20

Such insulation, if any shall be such that it cannot be damaged during mounting or in normal use

Compliance is checked by inspection and by the tests of clause 20

If the insulation of a conductor is not at least electrically equivalent to that of cables and cords complying with the appropriate IEC standard and does not comply with the dielectric strength test made between the conductor and metal foil wrapped around the insulation under the conditions specified in clause 15, the conductor is considered to be a bare conductor

12.1.4 For electronic switches with combinations of semiconductor switching devices and mechanical switching devices, the contacts connected in series with the semiconductor switching device shall be in compliance with the requirements for full disconnection or micro-disconnection.

12.1.5 For mechanical switching devices connected in parallel to the semiconductor switching devices, no requirements concerning the type of disconnection are specified

12.2 Constructional requirements relating to safety during mounting and normal operation of the switch

12.2.1 Covers, cover plates, removable actuators and the like providing safety shall be fixed in such a way that they cannot be displaced or removed except by use of a tool The fixings for a cover or cover plate shall not serve to fix any other part except an actuating member

It shall not be possible to mount removable parts, for example cover plates bearing indicators or knobs, such that indication of switch positions does not correspond with the actual switch position

12.2.2 Fixing screws of covers or cover plates shall be captive.

The use of tight-fitting washers of cardboard or similar material is deemed to be adequate for this purpose.

12.2.3 A switch shall not be damaged when its actuating member is removed as intended.

Compliance with the requirements of 12.2.1, 12.2.2 and 12.2.3 is checked by inspection and, for actuating members which do not require a tool for their removal, by the tests of 18.4.

12.2.4 A pull-cord shall be insulated from live parts and designed such that it shall be possible to fit or to replace it without removing parts causing live parts to become accessible.

Compliance is checked by inspection.

12.2.5 If an illuminated indicator is incorporated in a switch, it shall provide the correct indication as declared by the manufacturer.

Compliance is checked by connecting the switch to a voltage not deviating by more than ±10 % of the marked voltage for the lamp circuit or rating of the switch, whichever is applicable.

12.3 Constructional requirements relating to the mounting of switches and to the attachment of cords

12.3.1 Switches shall be designed so that the methods of mounting in accordance with the manufacturer's declarations do not adversely affect compliance with this standard.

12.3.1.1 These methods of mounting shall be such that the switch cannot rotate, or be otherwise displaced, and cannot be removed from an appliance without the aid of a tool. If the removal of a part, such as a key, is necessary during the normal use of the switch, then the requirements of clauses 9, 15 and 20 shall be satisfied before and after such removal.

Compliance is checked by inspection and by manual test.

a) Switches fixed by a nut and a single bush concentric with the actuating means are deemed to comply with this requirement, provided that the tightening and/or loosening of the nut requires the use of a tool, and that the parts have adequate mechanical strength.

b) An incorporated switch mounted by screwless fixing is deemed to comply with this requirement if the use of a tool is required before the switch can be removed from the appliance.

13 Mechanism

For electronic switches, these requirements apply only to those electronic switches provided with mechanical switching devices

13.1 For d c. switches, the speed of contact making and breaking shall be independent of the speed of actuation, except for those switches with either a rated voltage not exceeding 28 V or a rated current not exceeding 0,1 A

13.2 Switches shall be constructed so that the moving contacts can come to rest only in the "ON" and "OFF" positions. An intermediate position is permissible if it corresponds to an intermediate position of the actuating member providing that this does not give a misleading indication of a marked "OFF" position and that the separation of the contacts is then adequate

A switch is deemed to be in the "ON" position as soon as the contact pressure is sufficient to ensure compliance with the requirements of clause 16.

A switch is deemed to be in the "OFF" position when the separation of the contacts is sufficient to ensure compliance with the requirements of clause 15

The adequacy of the separation of the contacts in an intermediate position is determined by compliance with the requirements of clause 15 as specified for the adjacent "OFF" position

13.3 When the actuating member is released, it shall take up automatically or stay in the position corresponding to that of the moving contacts, except that, for switches which have only one rest position, the actuating member may take up its normal rest position

Compliance with the requirements of 13 1, 13 2 and 13 3 is checked by manual test, the switch being mounted according to the manufacturer's declarations and the actuating member being actuated as in normal use.

If necessary, the adequacy of the separation of the contacts in an intermediate position is determined by a dielectric strength test in accordance with 15 3, the test voltage being applied between the relevant terminals, without removing any cover

13.4 A cord-operated switch shall be constructed so that, after actuating the switch and releasing the cord, the relevant parts of the mechanism are in a position from which they allow the immediate performance of the next movement in the cycle of actuation

Compliance is checked by inspection and by the following test

Cord-operated switches shall be actuated from any one position to the next position, by the application and removal of a steady pull not exceeding 45 N vertically downwards, or 70 N at 45° to the vertical, with the switch mounted as declared

13.5 Multi-pole switches shall make and break all related poles substantially together unless otherwise declared according to 6.2 of table 3 For switches with switched neutral, the neutral may make before and break after the others

Compliance is checked by inspection and, if necessary, by test.

14 Protection against solid foreign objects, ingress of dust, water, and humid conditions

14.1 Protection against solid foreign objects

Switches shall provide the declared degree of protection as in 13.3 of IEC 60529, against solid foreign objects when mounted and used as declared.

Compliance is checked by the appropriate test specified in IEC 60529.

Detachable parts are removed. A switch which relies on mounting in, or on, an appliance for the declared degree of protection against solid foreign objects shall be suitably mounted in, or on, a closed box to simulate the appliance, and the tests shall be performed using this simulated assembly.

14.2 Protection against ingress of dust

Switches shall provide the declared degree of protection against ingress of dust when mounted and used as declared.

Compliance is checked by the dust test according to IEC 60529, test for first characteristic numeral 5 or 6.

a) The test is carried out according to category 2 of IEC 60529.

b) The switches are placed in a position of normal use inside the test chamber. Detachable parts are removed. A switch which relies on mounting in, or on, an appliance for the declared degree of protection against ingress of dust shall be suitably mounted in, or on, a closed box to simulate the appliance, and the tests shall be performed using this simulated assembly.

c) The test shall be continued for a period of 8 h. During the 8 h period, the switch under test shall be alternatively loaded for 1 h with the maximum rated current and 1 h without current.

d) For the test for first characteristic numeral 5, the switch is deemed to comply if

- *all actions function as declared;*
- *the temperature rise at the terminals does not exceed 55 K when tested in accordance with 16.2, with the exception that the temperature-rise test at the terminals is carried out at rated current and at an ambient temperature of 25 °C ± 10 °C;*
- *the dielectric strength requirement of 15.3 applies with the exception that the specimens are not subjected to the humidity treatment before the application of the test voltage. The test voltage shall be 75 % of the corresponding test voltage specified in 15.3;*
- *there is no evidence that transient fault between live parts and earth metal, accessible metal parts, or actuating members has occurred.*

e) For the test for first characteristic numeral 6, the protection is satisfactory if no deposit of dust is observable inside the switch at the end of the test.

f) The switch shall be tested in the most unfavourable position taking into consideration the manufacturer's declarations.

14.3 Protection against ingress of water

Switches shall provide the declared degree of protection against ingress of water when mounted and used as declared.

Compliance is checked by the appropriate tests specified in IEC 60529 with the switch placed in any position of normal use. Switches are allowed to stand at 25 °C ± 10 °C for 24 h before being subjected to the following test.

The test is then carried out according to IEC 60529 as follows:

- *IPX1 switches as described in 14.2.1 with the drain holes open;*
- *IPX2 switches as described in 14.2.2 with the drain holes open,*
- *IPX3 switches as described in 14.2.3 with the drain holes closed,*
- *IPX4 switches as described in 14.2.4 with the drain holes closed,*
- *IPX5 switches as described in 14.2.5 with the drain holes closed;*
- *IPX6 switches as described in 14.2.6 with the drain holes closed;*
- *IPX7 switches as described in 14.2 7 with the drain holes closed.*

Immediately after the appropriate test, the switch shall withstand the dielectric strength test specified in 15.3, and inspection shall show that there is no trace of water on insulation which could result in a reduction of creepage and clearance below the values specified in clause 20

a) *The switch shall not be electrically loaded during these tests The water temperature shall not differ from that of the switch by more than 5 K.*

b) *Detachable parts are removed.*

c) *Switches incorporating separate gaskets, screwed glands, membranes or other sealing means, manufactured from rubber or thermoplastic materials, are aged in a heating cabinet with an atmosphere having the composition and pressure of the ambient air and ventilated by natural circulation*

d) *Switches without T-rating are kept in the cabinet at a temperature of 70 °C ± 2 °C, and switches with T-rating are kept in the cabinet at a temperature of T + 30 °C for 240 h Switches with glands or membranes are fitted and connected with conductors as specified in clause 11 Glands are tightened with a torque as specified in table 21. Fixing screws for enclosures are tightened with a torque as specified in table 20.*

e) *Immediately after ageing, the parts are taken out of the cabinet and left at 25 °C ± 10 °C, avoiding direct daylight, for at least 16 h.*

f) *A switch which relies on mounting in, or on, an appliance for the declared degree of protection against harmful ingress of water shall be suitably mounted in, or on, a closed box to simulate the appliance, and the tests shall be performed using this simulated assembly.*

g) *For the tests of second characteristic numerals 3 and 4, preferably the hand-held spray nozzle specified in IEC 60529 shall be used.*

14.4 Protection against humid conditions

All switches shall be proof against humid conditions which may occur in normal use.

Compliance is checked by the humidity treatment described in this subclause, followed immediately by the tests of 15.2 and 15.3. Cable inlet openings, if any, and drain-holes are left open. If a drain-hole is provided for a water-tight switch, it is opened.

a) Detachable parts are removed and subjected, if necessary, to the humidity treatment with the main part.

b) The humidity treatment is carried out in a humidity cabinet containing air with a relative humidity between 91 % and 95 %. The temperature of the air, at all places where specimens can be located, is maintained within ±1 °C of any convenient value (t) between 20 °C and 30 °C.

c) Before being placed in the humidity cabinet, the specimens are brought to a temperature between t and t + 4 °C.

The specimens are kept in the cabinet for 96 h.

d) Immediately after this treatment, the tests of 15.2 and 15.3 are made either in the humidity cabinet, or in the room in which the specimens were brought to the prescribed temperature after the reassembly of any detached parts.

The switch shall not show any damage such as to impair compliance with this standard.

NOTE 1 In most cases, the specimens may be brought to the specified temperature by keeping them at this temperature for at least 4 h before the humidity treatment.

NOTE 2 In order to achieve the specified conditions within the cabinet, it is necessary to ensure constant circulation of the air and, in general, to use a cabinet which is thermally insulated.

15 Insulation resistance and dielectric strength

15.1 The insulation resistance and the dielectric strength of switches shall be adequate.

Compliance is checked by the tests of 15.2 and 15.3, the tests being made immediately after the test of 14.4.

The test voltage according to table 12 is applied in the case of

- *operational insulation: between the different poles of a switch. For the purpose of the test, all the parts of each pole are connected together;*
- *basic insulation: between all live parts connected together and a metal foil covering the outer accessible surface of the basic insulation and accessible metal parts in contact with the basic insulation;*
- *double insulation: between all live parts connected together and a metal foil covering the outer, normally not accessible surface of basic insulation and non-accessible metal parts; and following this: between two metal foils covering separately the inner, normally not accessible surface of supplementary insulation and connected to non-accessible metal parts, and the outer, accessible surface of supplementary insulation and connected to accessible metal parts;*
- *reinforced insulation: between all live parts connected together and a metal foil covering the outer accessible surface of reinforced insulation and accessible metal parts;*
- *contacts: between the open contacts of each pole of a switch.*

The foils are not pressed into openings but are pushed into corners and the like by means of the standard test finger.

In cases where basic insulation and supplementary insulation cannot be tested separately, the insulation provided is subjected to the test voltages specified for reinforced insulation.

For electronic switches, the test is carried out across full disconnection and micro-disconnection only on electronic switches with mechanical switching devices connected in series with the semiconductor switching device

For electronic switches, the tests are not carried out across protective impedances and poles interconnected by components.

15.2 *The insulation resistance is measured with a d c voltage of approximately 500 V applied, the measurement being made 1 min after application of the voltage*

The insulation resistance shall not be less than specified in table 11

Table 11 – Minimum insulation resistance

Insulation to be tested	*Insulation resistance* MΩ
Operational	2
Basic	2
Supplementary	5
Reinforced	7

NOTE Materials such as ceramic or porcelain are considered to have adequate insulation resistance and are not subjected to the insulation resistance tests

15.3 *The insulation is subjected to a voltage of substantially sine-wave form having a frequency of 50 Hz or 60 Hz The test voltage shall be raised uniformly from 0 V to the value specified in table 12 within not more than 5 s and held at that value for 5 s*

No flashover or breakdown shall occur Glow discharges without drop in voltage are neglected

Table 12 – Dielectric strength

Insulation or disconnection to be tested [2]	Test voltage (r.m.s.) [1]			
	Rated voltage up to and including 50 V	Rated voltage above 50 V up to and including 130 V	Rated voltage above 130 V up to and including 250 V	Rated voltage above 250 V up to and including 440 V
	V	V	V	V
Functional insulation [3]	500	1 300	1 500	1 500
Basic insulation [4]	500	1 300	1 500	1 500
Supplementary insulation [4]		1 300	1 500	1 500
Reinforced insulation [4] [5]	500	2 600	3 000	3 000
Across electronic disconnection	100	400	500	700
Across micro-disconnection	100	400	500	700
Across full disconnection	500	1 300	1 500	1 500

NOTE 1 Up to 50 V. Not intended to be connected direct to the mains and not expected to be subjected to temporary overvoltages as defined in IEC 60364-4-442.

NOTE 2 Over 50 V: The values are based on IEC 60364-4-442.

- For functional, basic and supplementary insulation, and for full disconnection, the values are calculated with the formula: U_N + 1 200 V and rounded.
- For micro and electronic disconnection, the values are calculated with the formula: U_N + 250 V and rounded.

NOTE 3 In this standard, the maximum voltage considered between line and neutral is U_N = 300 V.

1) The high-voltage transformer used for the test shall be designed so that, when the output terminals are short-circuited after the output voltage has been adjusted to the test voltage, the output current is at least 200 mA. The overcurrent relay shall not trip when the output current is less than 100 mA. Care is taken that the r.m.s. value of the test voltage is measured within ±3 %.

2) Special components which might render the test impractical such as discharge lamps, coils, windings, or capacitors are disconnected at one pole, or bridged, as appropriate to the insulation being tested. Where this is not practical on the specimens to be used for the test of clauses 16 and 17, the test of 15.3 shall be carried out on additional specimens. These may be special specimens with the appropriate components omitted.

3) An example is the insulation between poles (see definition 3.7.5).

4) For the test of basic, supplementary and reinforced insulation, all live parts are connected together and care is taken to ensure that all moving parts are in the most onerous position.

5) For switches incorporating reinforced insulation as well as double insulation, care is taken that the voltage applied to the reinforced insulation does not overstress the basic or the supplementary parts of the double insulation.

16 Heating

16.1 General requirements

Switches shall be constructed so that they do not attain excessive temperatures in normal use The materials used shall be such that the performance of the switches is not adversely affected by operation in normal use at the maximum rated current or declared thermal current and rated temperature of the switch.

16.2 Contacts and terminals

16.2.1 The material and design of the contacts and terminals shall be such that the operation and performance of the switch is not adversely affected by their oxidation or other deterioration.

16.2.2 *Compliance is checked by inspection and by the following tests*

The tests are carried out as follows.

a) Switches with terminals for unprepared conductors are fitted with conductors of a minimum length of 1 m, unless the manufacturer declares a length below 1 m, and having the medium cross-sectional area specified in table 4.

b) Switches with terminals for prepared conductors are fitted with conductors of a length of 1 m or less, if so declared by the manufacturer, and having the appropriate cross-sectional area as declared by the manufacturer

c) Terminal screws and/or nuts are tightened with a torque equal to two-thirds of that specified in the appropriate column of table 20

d) Actuating members of biased switches are fixed in the declared "ON" position.

e) On switches fitted with screwless terminals, care should be taken to ensure that the conductors are correctly fitted to the terminals in accordance with clause 11

f) The poles of switches which make simultaneously may be connected in series by means of conductors The minimum length of the conductors between two poles shall be 1 m unless the manufacturer declares a length below 1 m.

g) The switches are placed or mounted as declared in a suitable heating or refrigerating cabinet without forced convection

NOTE 1 A cabinet with forced convection may be used, provided the test specimen(s) is (are) not effected by this forced convection.

NOTE 2 Electronic switches need not be placed in a heating or refrigerating cabinet.

h) Switches with a T-rating up to and including 55 °C are tested at a temperature of 20 °C ± 2 °C without forced convection. Switches with T-rating above 55 °C are placed in a heating cabinet without forced convection and the temperature is raised to the T-rating of the switch The temperature of the cabinet is maintained at T ± 5 °C or T ± 0,05 T, whichever is greater

i) The temperature of the air in which the specimens are placed shall be measured as near as possible to the centre of the space occupied by the specimens and at a distance approximately 50 mm from the specimen.

j) The test circuit is shown in figure 18. The load is set with switch A closed.

The specimens are subjected to 20 operating cycles with no current flowing. The actuating member is left in the most unfavourable "ON" position and the switches are loaded with a current of 1,06 times the maximum rated current for resistive load. If there are more "ON" positions, then the verification shall be realized at the most unfavourable one. Any convenient a.c. or d.c. voltage may be used for the test circuit.

In case of doubt about the test results, the test shall be carried out at the rated voltage and rated resistive load current. For switches designed for a.c. voltage and switches rated for d.c. voltage where no polarity is given, the test performed with d.c. voltage shall be performed in both polarities and an average value calculated.

Multiway switches classified according to 7.1.13.4.1 to 7.1.13.4.5 are loaded as specified in 17.2.1.1 resulting in the maximum heating.

The division of the individual loads for switches for declared specific load shall follow the manufacturer's declaration.

k) Components (other than contacts and their associated current-carrying parts) which may produce heat or influence the temperature at the terminals are not energized during the test. These components should be disconnected, or the voltage for the test chosen to ensure the minimum heating effect.

l) The maximum rated current is maintained at least for 1 h or until a constant temperature at the terminals is attained. A temperature is considered to be constant when three successive readings taken at intervals of 5 min indicate no change greater than ±2 °C.

NOTE Care should be taken to ensure that the test current remains stable during the duration of this test.

m) Temperature at the terminals is determined by means of fine wire thermocouples which are positioned so that they have negligible effect on the temperature being determined, the measuring points are positioned on the terminals as close as possible to the body of the switch. If the thermocouples cannot be positioned directly on the terminals, the thermocouples may be fixed on the conductors as close as possible to the switch.

n) The temperature rise at the terminals shall not exceed 45 K.

o) For electronic switches, the following additional test conditions apply:

- *for the tests of electrical contacts connected in series with a semiconductor switching device, the semiconductor switching device is short-circuited;*
- *cord switches shall be tested laying on a dull black painted plywood surface in the normal position;*
- *if the switch has a mechanical contact which is connected in parallel to the semiconductor switching device, the temperature rise is measured immediately before the contacts close. Alternatively, the temperature rise of the switch may be measured on specially prepared specimens:*
  - *switches classified according to 7.1.17.1, 7.1.17.2 and 7.1.17.4 are tested as prescribed in a) to n), using resistive load;*
  - *switches for specific test conditions of end application (see 7.1.17.3) are tested in or together with the appliance(s).*

16.3 Other parts

16.3.1 Other parts of switches shall not attain excessive temperatures such that the performance or operation of the switch is impaired or a hazard is presented to the user and/or the immediate surroundings of the switch in normal use

16.3.2 *For mechanical switches, compliance is checked by the following tests.*

a) The switches shall be mounted as declared and fitted with conductors and loaded with a test current as prescribed in 16.2.2 with the additional requirement that the test on all switches is carried out at the maximum rated temperature.

b) For switches only partially suitable for a rated ambient temperature higher than 55 °C, those parts which are accessible when the switch is mounted as declared shall be exposed to a temperature not higher than 55 °C.

c) The temperature of metal mounting surfaces of the test equipment shall be between T and 20 °C.

d) If other heating sources are incorporated or integrated in the switch, these circuits shall be of the maximum power declared and are connected to a supply having a voltage between 0,94 and 1,06 times the rated voltage, whichever will produce the most heat

NOTE Examples of such heating sources are tungsten filament lamps or discharge lamp assemblies incorporating resistors.

e) The temperature of the parts and/or surfaces of the switch indicated in table 13 shall be determined by means of fine wire thermocouples or other equivalent means, so chosen and positioned that they have the minimum effect on the temperature of the part under test

f) Thermocouples used for determining the temperature of surfaces are attached to the back of blackened discs of copper or brass 5 mm in diameter and 0,8 mm thick

As far as possible, the discs are positioned on that part of the surface likely to attain the highest temperature in normal use.

g) In determining the temperature of actuating members, consideration has to be given to all parts which are gripped in normal use and to non-metallic parts where they are in contact with hot metal.

h) During this test, the temperatures shall not exceed the values specified in table 13.

NOTE The temperature limits of table 13 are based on the values specified in IEC 60335-1 Since these values are under consideration, it will be necessary to review them.

16.3.3 *For electronic switches, compliance is checked by the following tests.*

a) The electronic switch shall be mounted as declared and fitted with conductors in accordance with table 4. The tests are carried out at the maximum rated temperature.

The test circuit is shown in figure 18. The load is set at rated voltage with switch A closed

During the test, the electronic switch shall be energized. The electronic switch is left in the most unfavourable ON position. If there are more than one ON positions, then the verification shall be realized at the most unfavourable one

If the switch has a mechanical contact which is connected in parallel to the semiconductor switching device, the temperature is recorded in the position immediately before the contact closes.

During the test, the voltage shall be between 0,94 and 1,06 times the rated voltage, whichever produces the most heat.

During the test with thermal current, one or few reference points are selected, and the temperatures are recorded.

NOTE 1 The temperature recordings may be used for comparative heating tests in the end application under maximum current and cooling conditions.

The load conditions are as follows:

- *for electronic switches for which no thermal current is declared, the tests are carried out with rated current and duty type;*
- *for electronic switches for which a thermal current is declared, the tests are carried out with the specified thermal current and duty type;*
- *for electronic switches for a specific end application, the tests are carried out in or together with the appliance.*

NOTE 2 The heating occurring at full load current of the end application with its rated duty-type, under the cooling conditions present at the end application, should not be higher than the values recorded during the test with thermal current.

NOTE 3 Information concerning the appropriate reference point(s) (for example, metal heat sink, insulating material related to the heat sink) may be given by the manufacturer.

b) *For electronic switches only partially suitable for a rated ambient temperature higher than 35 °C or 55 °C (classifications 7.1.3.4 or 7.1.3.1), those parts which are accessible when the electronic switch is mounted as declared shall be exposed to a temperature not higher than 35 °C or 55 °C.*

c) *The temperature of metal mounting surfaces of the test equipment shall be between T and the ambient temperature.*

d) *If heating sources other than the electronic components are incorporated or integrated in the electronic switch, these circuits shall be of the maximum power declared and are connected to a supply having a voltage between 0,94 and 1,06 times the rated voltage, whichever will produce the most heat.*

NOTE Examples of such heating sources are tungsten filament lamps or discharge lamp assemblies incorporating resistors.

e) *The temperature of the parts and/or surfaces of the switch indicated in table 13 shall be determined by means of fine wire thermocouples or other equivalent means, so chosen and positioned that they have the minimum effect on the temperature of the part under test*

The maximum temperatures of windings are determined by the resistance method by calculating the temperature rise t and adding this value to the ambient temperature.

The temperature rise of copper windings is calculated from the formula:

$$t = (R_2 - R_1)(234{,}5 + t_1) / R_1 - (t_2 - t_1)$$

where

t is the temperature rise;

R_1 is the resistance at the beginning of the test;

R_2 is the resistance at the end of the test;

t_1 is the ambient temperature at the beginning of the test;

t_2 is the ambient temperature at the end of the test.

At the beginning of the test, the windings shall be at ambient temperature.

NOTE It is recommended that the resistance of windings at the end of the test be determined by taking resistance measurements as soon as possible after switching off, and then at short intervals so that a curve of resistance against time can be plotted for ascertaining the resistance at the instant of switching off.

f) *Thermocouples used for determining the temperature of surfaces are attached to the back of blackened discs of copper or brass 5 mm in diameter and 0 8 mm thick*

As far as possible, the discs are positioned on that part of the surface likely to attain the highest temperature in normal use

g) *In determining the temperature of actuating members, consideration has to be given to all parts which are gripped in use and to non-metallic parts where they are in contact with hot metal*

h) *The setting, if any, is adjusted in such a way that the highest temperature rise will occur During the test, the switch state shall not change, fuses and other protective devices shall not operate and the permissible maximum temperatures in table 13, first column, shall not be exceeded.*

NOTE 1 Small unintended variations of the switch state, for example reversible variation of phase angle are disregarded

NOTE 2 During the test, the temperatures necessary to perform the test of 21 1 and annex E are to be measured

Table 13 - Permissible maximum temperatures

Parts	Maximum temperature	
	Normal conditions Subclauses 16.3 2 and 16.3 3 °C	Abnormal conditions Clause 23 °C
Rubber or polyvinyl chloride insulation of non-detachable cables and cords		
– without T-marking.	75 [1]	135
– with T marking	T	135
Cord sheaths used as supplementary insulation	60	120
Rubber other than synthetic, used for gaskets or other parts, the deterioration of which could affect safety		
– when used as supplementary insulation or as reinforced insulation	65	125
– in other cases	75	135
Material used as insulation other than that specified for wires		
– printed circuit boards	[3]	
Moulding of		
– thermosetting materials	[4], [9]	[4], [9]
– thermoplastic materials	[4]	[4]
All accessible surfaces except those of actuating members or handles	85	100
Accessible surfaces of actuating members or handles which are held for short periods only		
– of metal	60	100
– of porcelain or vitreous material	70	100
– of moulded material or rubber	85	100

Table 13 (*Continued*)

Parts	Maximum temperature	
	Normal conditions Subclauses 16.3.2 and 16.3.3 °C	Abnormal conditions Clause 23 °C
Inside of enclosures of insulating material	[5]	[5]
Windings – Thermal classification [6]		
– class A	100	135
– class E	115	150
– class B	120	155
– class F	145	180
– class H	165	200
– class 200	185	220
– class 220	205	240
– class 250	235	270
Terminals and terminations for unprepared conductors	80 [7]	125 [8]
Other terminals and terminations	[7]	125 [8]

1) This limit applies to cables, cords and wires complying with the relevant IEC standards, for others, it may be different.

2) This limit will become applicable as soon as there are IEC standards for high-temperature cables, cords and wires

3) The material must be according to IEC 60893-1 The maximum permissible temperature shall not exceed values which can be proved to be safe in service for the materials in question

4) There is no specific limit The material shall withstand the test of clause 21, for which purpose the temperature shall be measured

5) The permissible temperature rises at the inside of enclosures of insulating material are those indicated for the relevant materials.

6) The thermal classification is the thermal class according to IEC 60085 with the following deductions which take into consideration the conventional difference between the average temperature and the maximum temperature

- Classes A and E ... 5 °C
- Classes B and F ... 10 °C
- Classes H to 250 ... 15 °C

7) The temperature measured shall not exceed 80 °C, unless a higher value has been declared by the manufacturer

8) The temperature measured shall not exceed 125 °C, unless a higher value has been declared by the manufacturer

9) For mechanical switches, the maximum permissible temperature shall not exceed that which can be shown to be safe in service for those materials The material shall withstand the test of clause 21, for which purpose the temperature shall be measured.

Table 14 – Temperatures for thermosetting materials used for electronic switches

Parts	Maximum temperature	
	Normal conditions Subclauses 16.3.2 and 16.3.3 °C	Abnormal conditions Clause 23 °C
Material used as insulation other than that specified for wires:		
– melamine-formaldehyde, phenol-formaldehyde or phenol-furfural resins	135 (225) [1]	145 (225) [1]
– urea-formaldehyde resin	115 (200) [1]	125 (200) [1]
Moulding of:		
– phenol-formaldehyde with cellulose fillers	110 (200) [1]	165 (200) [1]
– phenol-formaldehyde with mineral fillers	125 (225) [1]	185 (225) [1]
– melamine-formaldehyde	100 (175) [1]	175
– urea-formaldehyde	90 (175) [1]	175
– polyester with glass-fibre reinforcement	135	185
– silicone rubber	170	225
– polytetrafluorethylene	290	290

[1] The values in parentheses apply if the material is in contact with hot metal parts, not submitted to electrical stress, however.

17 Endurance

17.1 General requirements

17.1.1 Switches shall withstand without excessive wear or other harmful effect the electrical, thermal and mechanical stresses that occur in normal use.

For all switches except electronic switches, compliance is checked as specified in 17.1.2.

For electronic switches, compliance is checked as specified in 17.1.3.

The different types of tests are specified in 17.2.4.

17.1.2 *The sequence of tests for all switches except electronic switches is as follows:*

- *a test at high speed specified in 17.2.4.3; this test only applies to switches with more than one pole, and where the type of connection is of polarity reversal;*
- *a test at slow speed specified in 17.2.4.2;*
- *an increased-voltage test at accelerated speed as specified in 17.2.4.1; this test does not apply to switches classified according to 7.1.2.9;*
- *a locked-rotor test as specified in 17.2.4.9 at accelerated speed; this test only applies to switches classified according to 7.1.2.9;*
- *a test at accelerated speed as specified in 17.2.4.4;*

- *a temperature-rise test in accordance with 16.2, with the exception that the temperature-rise test at the terminals is carried out at rated current and in an ambient temperature of 25 °C ± 10 °C;*
- *a dielectric strength test in accordance with 15.3, with the exception that the specimens are not subjected to the humidity treatment before the application of the test voltage The test voltage shall be 75 % of the corresponding test voltage specified in that subclause*

17.1.3 *Electronic switches are tested as specified in table 15 and according to the following test conditions depending on their classification in 7 1 17*

- *under functional test conditions according to 7 1 17 1 with thermal current or with maximum rated resistive current, if no thermal current is declared, and without forced cooling,*
- *under simulated test conditions according to 7 1.17 2 and with type of load according to 7.1 2 and under the cooling conditions classified in 7 1 15 and with test conditions as specified in tables 17 and 18;*
- *under specific test conditions of end application according to 7 1 17 3, in or together with the appliance and under the cooling conditions of the appliance,*
- *under test conditions according to duty type according to 7.1 17 4, the tests may be performed in combination with simulated test conditions or specific test conditions of the end application*

NOTE Additional mechanical operating means (for example actuating members such as speed-limit settings for electric tools) are ignored.

The electrical, thermal and mechanical conditions of these tests shall be as specified in 17 2 1 17 2 2 and 17 2 3.

Table 15 – Electrical endurance tests for the different types of electronic switches with or without electrical contact(s)

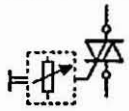
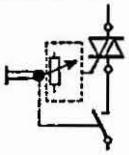
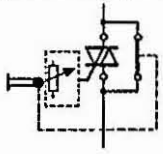
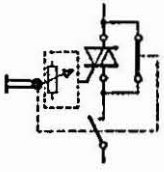
Type of electronic switch[3]		Test conditions					
		Functional test (7.1.17.1)		Simulated test (7.1.17.2) (Tables 17, 18)		Specific test condition of end application (7.1.17.3)	
		Complete switch	Contacts only	Complete switch	Contacts only	Complete switch	Contacts only
SSD [1] without electrical contact(s)		TL1 TC5, TC6, TC8 TE1, TE3	---	TL3 TC5, TC6, TC8 TE1, TE3	---	TL4 TC5, TC6, TC8 TE1, TE3	---
SSD with serial contact(s)		TL1 TC5, TC6, TC8 TE1, TE3	Serial contact: TC1, TC4 with TL2 TE1 to TE3 (SSD short-circuited) [2]	TL3 TC5, TC6, TC8 TE1, TE3	Serial contact: TC1, TC7 with TL3 TE1 to TE3 (SSD short-circuited) [2]	TL4 TC5, TC8 TE1, TE3	Serial contact: TC7 with TL4 TE1 to TE3 (SSD short-circuited) [2]
SSD with parallel contact(s)		TL1 TC5, TC6, TC8 TE1, TE3	Parallel contact: TC1, TC4 with TL2 TE1 to TE3 (SSD disconnected)	TL3 TC5, TC6, TC8 TE1, TE3	Parallel contact: TC1, TC7 with TL3 TE1 to TE3 (SSD disconnected)	TL4 TC5, TC8 TE1, TE3	Parallel contact: TC7 with TL4 TE1 to TE3 (SSD disconnected)
SSD with serial and parallel contact(s)		TL1 TC5, TC6, TC8 TE1, TE3	Serial contact: TC1, TC4 with TL2 TE1 to TE3 (SSD short-circuited) [2]	TL3 TC5, TC6, TC8 TE1, TE3	Serial contact: TC1, TC7 with TL3 TE1 to TE3 (SSD short-circuited) [2]	TL4 TC5, TC8 TE1, TE3	Serial contact: TC7 with TL4 TE1 to TE3 (SSD short-circuited) [2]
			Parallel contact: TC1, TC4 with TL2 TE1 to TE3 (SSD disconnected)		Parallel contact: TC1, TC7 with TL3 TE1 to TE3 (SSD disconnected)		Parallel contact: TC7 with TL4 TE1 to TE3 (SSD disconnected)

Table 15 *(continued)*

T_{L} = type of test load
TL1 = thermal current or maximum rated resistive current, if no thermal current is declared
TL2 = maximum rated resistive current
TL3 = rated load (7.1.2)
TL4 = declared specific load (7.1.2.5)
TC = type of test condition:
TC1 = increased-voltage test at accelerated speed (17.2.4.1)
TC2 = test at slow speed (17.2.4.2)
TC3 = test at high speed (17.2.4.3)
TC4 = test at accelerated speed (17.2.4.4)
TC5 = manual functional test, 20 times at maximum manual operating speed to perform the full function of the electronic switch (17.2.4.5)
TC6 = test at minimum load (17.2.4.6)
TC7 = test condition according to TC4, number of operating cycles 1 000 or the declared number of cycles whichever is the lowest (17.2.4.7)
TC8 = full number of operating cycles at accelerated speed (17.2.4.8)
TE = type of evaluation test
TE1 = functional compliance (17.2.5.1)
TE2 = thermal compliance (17.2.5.2)
TE3 = insulating compliance (17.2.5.3)
1) SSD = semiconductor switching device
2) The short circuit shall be performed in a way to allow the terminals and contacts and other parts designed for the maximum rated current to be loaded with the maximum rated current
3) For combinations of SSD and mechanical contacts, where the function of the SSD and the mechanical contacts are independent of each other, the requirements of Part 1 apply for the mechanical contacts

17.1.4 After all the tests specified, the specimens shall meet the requirements of 17.2.5.

17.2 Electrical endurance tests

17.2.1 Electrical conditions

17.2.1.1 *The switch shall be loaded as specified in table 17 and/or table 18 and connected in accordance with the circuit(s) as given in table 2 if applicable, following the declaration according to 7.1.13.*

Switches of a declared specific type and/or connection are connected and loaded as specified by the manufacturer.

Circuits and contacts which are not intended for external loads are operated with the designated load.

Where, in table 2, an auxiliary switch (A) is symbolized in the test circuit, the tests for the two ON-positions of the specimen (S) are performed on two separate sets of test samples. The connection to the test load to be performed for the two tests is symbolized in table 2 by an auxiliary switch A.

Multiway switches classified according to 7.1.13.4.2 to 7.1.13.4.5 are loaded according to table 16.

Table 16 – Test loads for multiway switches

Operating cycles	Switch position of	Type of switch Subclause	Load
First half	Highest load	7.1.13.4.2 to 7.1.13.4.5	I_R
	Next lower load	7.1.13.4.2 to 7.1.13.4.5	$0,8 \times I_R$
	Further next lower load	7.1.13.4.5	$0,533 \times I_R$
Second half	Highest load	7.1.13.4.2 to 7.1.13.4.5	I_R
	Next lower load	7.1.13.4.2 to 7.1.13.4.5	$0,5 \times I_R$
	Further next lower load	7.1.13.4.5	$0,333 \times I_R$

The load for the other switch positions is that resulting from the loads necessary to achieve the conditions specified above

For circuits according to 7.1 2 7 for specific lamp load, the connection and test load is as specified by the manufacturer using the maximum occurring inrush current at room temperature.

No electrical endurance tests are necessary for switches for 20 mA load as classified in 7.1.2.6.

NOTE For a specific lamp load, it is recommended that the specimen be operated with loads that are used in the field rather than with synthetic loads. Forced cooling of the specific lamp load may be applied in order to ensure cold resistance for each operating cycle and shorten the test time.

For electronic switches, the test circuit shall be as shown in figure 19 The declared load shall be set at rated voltage before the electronic switch is inserted into the circuit

17.2.1.2 *When increased-voltage conditions are specified, the loads used are those specified for tests at rated voltage, the voltage then being increased to 1,15 the rated voltage*

For test circuits for capacitive load tests and simulated lamp load tests for a c circuits the test voltage is the rated voltage and the test currents are increased to 1 15 rated currents

Table 17 – Test loads for electrical endurance tests for a.c. circuits

Type of circuit as classified in 7.1.2	Operation of contacts	Test voltage	Test current r.m.s.	Power factor [3]
Substantially resistive (classified in 7.1.2.1)	Making and breaking	Rated voltage	*I-R*	≥0,9
Resistive and/or motor (classified in 7.1.2.2)	Making [2]	Rated voltage	6 × *I-M* or *I-R* [1]	0,60 (+0,05) ≥0,9
	Breaking	Rated voltage	*I-R* or *I-M* [1]	≥0,9 ≥0,9 [5]
Circuit for specific load of motor with a locked rotor and with a power factor not less than 0,6 (classified in 7.1.2.9)	Making	Rated voltage	6 × *I-M*	0,60 (+0,05)
	Breaking	Rated voltage	6 × *I-M*	0,60 (+0,05)
Circuit for an inductive load (classified in 7.1.2.8)	Making [2]	Rated voltage	6 × *I-I*	0,60 (+0,05)
	Breaking	Rated voltage	*I-I*	0,60 (+0,05)
Resistive and capacitive (classified in 7.1.2.3)	Making and breaking	Tested in a circuit as shown in figure 9a		
Tungsten filament lamp load (classified in 7.1.2.4)	Making and breaking	Tested in a circuit as shown in figure 9a [4] Rated voltage ≥ 110 V a.c., $X = 16$ Rated voltage < 110 V a.c., $X = 10$		
Circuit for specific lamp load (classified in 7.1.2.7)	Making and breaking	Rated voltage	As determined by load	
Specific declared (classified in 7.1.2.5)	Making and breaking	Rated voltage	As determined by load	

NOTE *I-I*: inductive-load current

I-M: motor-load current

I-R: resistive-load current

1) Whichever is arithmetically greater or the most unfavourable value in case of equal values.

2) The specified making conditions are maintained for a period between 50 ms and 100 ms, and are then reduced by an auxiliary switch to the specified breaking conditions.

For all switches except electronic switches the test current may be reduced to *I-R* by introducing a resistor in the circuit. Short interruptions of the test current during the reduction to *I-R* not exceeding a period of 50 ms to 100 ms are permitted.

For electronic switches, the reduction to the break current should be achieved without any open circuiting of the simulated inductive loads circuit, to ensure that no abnormal voltage transients are generated.

A typical method of achieving this is shown in figure 19.

3) Resistors and inductors are not connected in parallel except that if any air-core inductor is used, a resistor taking approximately 1 % of the current through the inductor is connected in parallel with it. Iron-core inductors may be used provided that the current has a substantial sine-wave form. For three-phase tests, three-core inductors are used.

4) In the case where the tests are performed with tungsten filament lamp bulbs, the following test conditions apply:

- the ratio $X = 16$ or $X = 10$ shall be achieved;
- the cold resistance of the lamps shall be ensured for each operating cycle;
- the resistance of connections within the load circuit (for example lamp sockets) shall be constant;
- the proper function of the lamps performing the load set shall be ensured for each operating cycle.

5) The test circuit condition for testing electronic switches, according to figure 18, shall be substantially resistive.

Table 18 – Test loads for electrical endurance tests for d.c. circuits

Type of circuit as classified in 7.1.2	Operation of contacts	Test voltage	Test current	Time constant
Substantially resistive load	Making and breaking	Rated voltage	I–R	L/R < 1,15 ms
Tungsten filament lamp load (classified in 7 1 2 4)	Making and breaking	Tested in a circuit as shown in figure 9b Rated voltage ≥ 110 V d.c., X = 16 Rated voltage ≤ 110 V d.c., X = 10 [1]		
Resistive and capacitive load (classified in 7 1 2 3)	Making and breaking	Tested in a circuit as shown in figure 9b		
Circuit for specific lamp load (classified in 7 1 2 7)	Making and breaking	Rated voltage	As determined by load	
Declared specific load (classified in 7 1 2.5)	Making and breaking	Rated voltage	As determined by load	

NOTE I–R resistive load current

[1] In case where the tests are performed with tungsten filament lamp bulbs, the following test conditions apply

- the ratio X=16 or X=10 shall be achieved
- the cold resistance of the lamps shall be ensured for each operating cycle,
- the resistance of connections within the load circuit (for example, lamp sockets) shall be constant;
- the proper function of the lamps performing the load set shall be ensured for each operating cycle.

17.2.2 Thermal conditions

17.2.2.1 *For switches according to 7 1 3 2 and 7 1 3 4 2, the tests in 17 2.4.4 are carried out for the first half of the test period at maximum ambient air temperature* T^{+5}_{0} *°C and for the second half of the test period at 25 °C ± 10 °C or at the minimum ambient air temperature* T^{0}_{-5} *°C if T is less than 0 °C*

17.2.2.2 *For switches according to 7 1 3.3, during the tests in 17.2.4.4, those parts that are declared for use at 0 °C to 55 °C shall be exposed to a temperature within this range for the complete test period.*

The ambient air temperature of the remainder of the switch shall, for the first half of the test period, be maintained at the maximum ambient air temperature T^{+5}_{0} °C

For the second half of the test period the tests are carried out at 25 °C ± 10 °C or at the minimum ambient air temperature T^{0}_{-5} *°C if T is less than 0 °C.*

17.2.3 Manual and mechanical conditions

17.2.3.1 *The switches are operated by means of its actuating member either manually or by an appropriate apparatus which is arranged to simulate normal actuation.*

The operating speed for the operating cycles shall be as follows:

For the tests of switches except electronic switches:

a) for slow speed:

- *approximately 9°/s for rotary actuations at an angle of operation ≤45°;*
- *approximately 18°/s for rotary actuations at an angle of operation >45°;*
- *approximately 20 mm/s for linear actuations.*

b) for high speed, the actuating member shall be actuated by hand as fast as possible. If a switch is normally provided without an actuating member, then a suitable actuating member should be supplied by the manufacturer for the purpose of this test.

c) for accelerated speed:

- *approximately 45°/s for rotary actuations at an angle of operation ≤45°;*
- *approximately 90°/s for rotary actuations at an angle of operation >45°;*
- *approximately 80 mm/s for linear actuations.*

For the tests of electronic switches:

d) for slow speed:

- *approximately 9°/s for rotary actions;*
- *approximately 5 mm/s for linear actions;*

e) for high speed, the actuation member shall be actuated by hand as fast as possible. If a switch is delivered without an actuating member, then a suitable actuating member should be supplied by the manufacturer for the purpose of this test;

f) for accelerated speed:

- *approximately 45°/s for rotary actions,*
- *approximately 25 mm/s for linear actions.*

17.2.3.2 *For biased switches, the actuating member shall be moved to the limit of travel of the opposite position.*

17.2.3.3 *During the slow-speed test, care is taken that the test apparatus drives the actuating member positively, without significant backlash between the apparatus and the actuating member.*

17.2.3.4 *During the accelerated speed test*

a) care shall be taken to ensure that the test apparatus allows the actuating member to operate freely, so that there is no interference with the normal action of the mechanism;

b) for switches designed for a rotary actuation where the movement is not limited in either direction, three-quarters of the total number of operating cycles in each test shall be made in a clockwise direction, and one-quarter in an anti-clockwise direction;

c) for switches which are designed for rotary actuation in one direction only, the test shall be performed in the designed direction, provided that it is not possible to rotate the actuating member in the reverse direction using the torques necessary for actuation in the designed direction;

d) additional lubrication shall not be applied during these tests;

e) the forces applied to the end stops of the actuating members shall not exceed the declared values (if any) for rotary and linear actuation. The declared full travel of the actuating member (if any) shall be applied during these tests.

17.2.3.4.1 *So far as the design allows, except for locked rotor tests as specified in 17 2.4 9, capacitive and simulated lamp load tests according to figure 9a and figure 9b, the switches are operated at a rate of*

- *30 operations per minute, if the rated current does not exceed 10 A;*
- *15 operations per minute, if the rated current exceeds 10 A, but is less than 25 A,*
- *7,5 operations per minute, if the rated current is 25 A or more,*

with the ON period being 25^{+5}_{0} % and the OFF period being 75^{+5}_{0} % of an operating cycle.

17.2.3.4.2 *For capacitive and simulated lamp load tests according to figure 9a and figure 9b, switches are operated at a rate of 2 s ON and 15 s OFF*

17.2.3.4.3 *For locked rotor tests, the switches are operated at a rate of 1 s ON and 30 s OFF*

17.2.4 Type of test condition (TC)

17.2.4.1 Increased-voltage test at accelerated speed (TC1)

The electrical conditions are those specified for increased-voltage in 17 2 1

The method of operation is that specified for accelerated speed in 17 2 3.

The number of operating cycles is 100.

17.2.4.2 Test at slow speed (TC2)

The electrical conditions are those specified in 17 2 1

The method of operation is that specified for slow speed in 17 2 3

The number of operating cycles is 100

17.2.4.3 Test at high speed (TC3)

This test applies only to switches which have more than one pole and when polarity reversal occurs.

The electrical conditions are those specified in 17 2 1

The method of operation is that specified for high speed in 17.2 3.

The number of operating cycles is 100.

17.2.4.4 Test at accelerated speed (TC4)

For all switches except electronic switches, the electrical conditions are those specified in 17.2.1.

For electronic switches, the electrical conditions are those specified in table 15.

The thermal conditions are those specified in 17.2.2.

The number of operating cycles is the number declared according to 7.1.4 less the number actually made during the tests of 17.2.4.1, 17.2.4.2 and 17.2.4.3.

For switches classified according to 7.1.13.4.2 to 7.1.13.4.5, the total number of operations shall be not more than 200 000.

The method of operation is that specified for accelerated speed in 17.2.3.

17.2.4.5 Manual functional test (TC5)

Semiconductor switching devices including their electronic control units incorporated in electronic switches are subjected to the following functional tests.

The electronic switch is loaded with thermal current or maximum rated resistive current, if no thermal current is declared, at rated voltage until steady-state temperatures are reached.

When tested with maximum rated resistive current, the voltage is then increased to 1,1 times rated voltage, and again allowed to stabilize.

The switch is operated 20 times at the fastest manual rate possible, over the whole range from minimum to maximum and back to minimum, by means of its actuating member.

During and after the test, the specimens shall operate correctly.

17.2.4.6 Functional test at minimum load (TC6)

For electronic switches for which a minimum load or minimum current is specified by the manufacturer, the characteristic is additionally tested with the specified minimum load or current at 0,9 times rated voltage.

The switch is operated 10 times over the whole range from minimum to maximum and back to minimum by means of its actuating member.

In addition, where appropriate, the switch is operated 10 times over the whole range from minimum to maximum and back to minimum by means of a remote control.

During and after the test, the specimens shall operate correctly.

17.2.4.7 Test with limited number of operations (TC7)

The electrical conditions are those specified in table 15

The thermal conditions are those specified in 17.2 2.

The number of operating cycles is 1 000 or the declared number of cycles whichever is the lowest

The method of operation is that specified in 17 2.3 for accelerated speed

17.2.4.8 Endurance test (TC8)

Full number of operating cycles with TL1 (table 15) at accelerated speed

17.2.4.9 Locked-rotor test (TC9)

For switches according to 7 1 2 9, the test load condition for making operation for resistive and/or motor load with a rated current of 6 × I-M and with a power factor of 0,6 is used for the making and breaking operation

NOTE The test simulates the locked rotor condition of a motor

The method of operation is that specified in 17 2 3 for accelerated speed

The number of operating cycles is 50

17.2.5 Evaluation of compliance

17.2.5 1 Functional compliance (TE1)

After all the appropriate tests of 17 2 4 the switch is deemed to comply if

- *all actions function as declared,*
- *no loosening of electrical or mechanical connections occur*
- *sealing compound shall not flow to such an extend that live parts are exposed*

17.2.5.2 Thermal compliance (TE2)

After all the appropriate tests of 17 2 4, the switch is deemed to comply if the temperature rise at the terminals does not exceed 55 K, when tested in accordance with 16 2, with the exception that the temperature-rise test at the terminals is carried out at rated current and in an ambient temperature of 25 °C ± 10 °C

17.2.5.3 Insulating compliance (TE3)

After all the appropriate tests of 17 2 4, the switch is deemed to comply if

- *the dielectric strength requirement of 15 3 applies with the exception that the specimens are not subjected to the humidity treatment before the application of the test voltage The test voltage shall be 75 % of the corresponding test voltage specified in that subclause,*
- *there is no evidence that any transient fault between live parts and earth metal, accessible metal parts, or actuating members has occurred*

18 Mechanical strength

18.1 Switches shall have adequate mechanical strength and be constructed so as to withstand such rough handling as may be expected in normal use.

18.1.1 Accessible parts of actuating members of switches for Class I and Class II appliances shall either have adequate mechanical strength or be such that adequate protection against electric shock is maintained if the actuating member is broken.

Compliance is checked by the tests of 18.2, 18.3 and 18.4, as appropriate, carried out sequentially.

18.2 *Switches are checked by applying blows to the specimen by means of the spring-operated impact test apparatus of IEC 60068-2-75.*

18.2.1 *The actuating member and all surfaces which are accessible when the switch is mounted as in normal use are tested with the impact test apparatus.*

Incorporated switches are mounted in a test device as shown in figure 11.

Switches where only the actuating member is accessible when mounted as declared are fixed to the metal plate shown in figure 11, so that they are between it and the sheet of plywood.

Blows are applied to all accessible surfaces, including actuating members, in a direction perpendicular to the surface of the point to be tested, the test apparatus being calibrated to deliver an energy of 0,5 Nm ± 0,04 Nm. Foot-actuated switches shall be subject to the same test, but using a test apparatus calibrated to deliver an energy of 1,0 Nm ± 0,05 Nm.

For all such surfaces, three blows are applied to every point that is likely to be weak.

Care shall be taken that the results from one series of three blows do not influence subsequent series. If there is doubt whether a defect has been caused by the application of preceding blows, this defect is neglected and the group of three blows which led to the defect is applied to the same place on a new specimen, which shall then withstand the test.

Foot-operated switches are, in addition, subjected to a force applied by means of a circular steel pressure plate with a diameter of 50 mm. The force is increased continuously from an initial value of about 250 N up to 750 N within 1 min, after which it is maintained at this value for 1 min. The switches are mounted as in normal use in a horizontal panel, with the operating means protruding, and the force is applied once.

After these tests, the switch shall still comply with the requirements of clauses 9, 13, 15 and 20. Insulating linings, barriers and the like shall not have worked loose. It shall still be possible to remove and to replace detachable and other external parts such as cover plates without these parts or their insulating linings being broken.

It shall still be possible to actuate the actuating member to provide the appropriate disconnection.

In case of doubt, supplementary insulation or reinforced insulation is subjected to a dielectric strength test as specified in 15.3.

Damage to the finish, small dents which do not reduce creepage distances or clearances below the values specified in clause 20, and small chips which do not adversely affect the protection against electric shock or moisture, are neglected. Cracks not visible to the unaided eye, and surface cracks in fibre reinforced mouldings and the like, are ignored. If a decorative cover is backed by an inner cover, fracture of the decorative cover is neglected if the inner cover withstands the test after removal of the decorative cover

18.3 *Cord-operated switches are submitted to an additional pull test as follows. The switch is mounted as declared by the manufacturer, and the pull-cord is subjected to a force, applied without jerks, first for 1 min in the normal direction, and then for 1 min in a direction 45° maximum from the normal direction. The minimum values of the pull force shall be as specified in table 19 or three times the values of the normal operating force if that is greater*

Table 19 – Minimum values of pull force

Rated current A	*Force* N	
	Normal direction	*45° from normal direction*
Up to and including 4	*50*	*25*
Over 4	*100*	*50*

After this test, the switch shall show no damage to impair compliance with this standard

18.4 *Switches supplied or intended to be fitted, with actuating members shall be tested as follows.*

First, a pull shall be applied for 1 min to try to pull off the actuating member

The pull to be applied is normally 15 N, but if the actuating member is intended to be pulled in normal use, the force is increased to 30 N.

Secondly, a push of 30 N for 1 min is then applied to all actuating members.

During these tests, a movement of the actuating member on the actuating means is acceptable provided this does not result in an incorrect indication of the switch position.

After both of these tests, the specimen shall show no damage to impair compliance with this standard

If a switch is intended to have an actuating member but is submitted for approval without, then a pull and a push of 30 N are applied to the actuating means.

Adhesives, except of the self-hardening type, are not deemed to be adequate to prevent loosening of the actuating member.

19 Screws, current-carrying parts and connections

19.1 General requirements for electrical connections

Electrical connections shall be designed so that contact pressure is not transmitted through insulating material other than ceramic, pure mica or other material with characteristics no less suitable, unless there is visual evidence of sufficient resiliency in the metallic parts to compensate for any possible shrinkage or distortion of the insulating material.

a) The suitability of the material is considered in respect to the stability of the dimensions within the temperature range applicable to the switch.

b) This requirement is not applicable to connections internal to a switch where the connection is used for lamps for indicating purposes and where the current in this circuit is equal or below 20 mA.

Compliance is checked by inspection.

19.2 Screwed connections

19.2.1 Screwed connections, electrical or other, shall withstand the mechanical stresses occurring in normal use.

19.2.2 Screws transmitting contact pressure shall be in engagement with a metal thread. Such screws shall not be of metal which is soft or liable to creep, such as zinc or aluminium.

19.2.3 Mechanical connections to be used during installation of switches may be made using *thread-forming tapping screws or thread-cutting tapping screws, only if the screws are supplied* together with the piece in which they are intended to be inserted. In addition, thread-cutting tapping screws intended to be used during installation shall be captive with the relevant part of the switch.

19.2.4 Thread-forming (metal sheet) screws shall not be used for the connection of current-carrying parts, unless they clamp these parts directly in contact with each other and are provided with a suitable means of locking. Thread-cutting (self-tapping) screws shall not be *used for the electrical connection of current-carrying parts, unless they generate a full metric* ISO thread or a thread of equivalent effectiveness. Such screws shall not, however, be used if they are likely to be operated by the user or installer, unless the thread is formed by a swaging action.

Provisionally, SI, BA and Unified threads are deemed to be of equivalent effectiveness to a metric ISO thread.

Compliance is checked by inspection and, for screws and nuts which are likely to be operated while the switches are being mounted and connected, by the following test.

The screws or nuts are tightened and loosened

- *10 times for screws in engagement with a thread of insulating material;*
- *5 times in all other cases.*

Nuts concentric with the button or dolly are tightened and loosened five times. If either thread is of insulating material, the torque is 0,8 Nm. If the threads are of metal, the torque is 1,8 Nm.

Screws in engagement with a thread of insulating material are completely removed and reinserted each time. When testing terminal screws and nuts, conductors having the cross-sectional areas specified in clause 11 are placed in the terminal The conductor is solid for terminals not intended for the connection of supply cables or cords or if the nominal cross-sectional area does not exceed 6 mm^2; in other cases, the conductor is stranded.

For terminals for the connection of supply cables or cords, the conductor shall have the largest cross-sectional area specified

Screws and nuts are tightened and loosened by means of a suitable test screwdriver or spanner, the torque applied when tightening being equal to that specified in the appropriate column of table 20, if not otherwise specified.

Table 20 – Torque values

Nominal diameter of thread mm		Torque Nm				
Over	Up to and including	I	II	III	IV	V
–	1,7	0,1	–	0 2	0,2	–
1,7	2 2	0,15	-	0,3	0,3	-
2 2	2,8	0,2	–	0,4	0,4	–
2,8	3,0	0,25	–	0 5	0,5	-
3,0	3,2	0,3	–	0,6	0,6	–
3,2	3,6	0,4	–	0 8	0,8	–
3 6	4,1	0,7	1 2	1 2	1 2	1 2
4 1	4,7	0 8	1 2	1 8	1 8	1 8
4 7	5 3	0 8	1 4	2 0	2 0	2,0
5 3	6	–	1 8	2 5	3 0	3 0
6	8	–	2 5	3 5	6,0	4,0
8	10	–	3 5	4 0	10,0	6 0
10	12	–	4 0	–	–	8,0
12	15	–	5,0	–	-	10,0

The conductor is moved each time the screw or nut is loosened

Column I applies to screws without heads if the screw, when tightened, does not protrude from the hole, and to other screws which cannot be tightened by means of a screwdriver with a blade wider than the diameter of the screw

Column II applies to nuts of mantle terminals with cap nuts which are tightened by means of a screwdriver

Column III applies to other screws which are tightened by means of a screwdriver

Column IV applies to screws and nuts, other than nuts of mantle terminals, which are tightened by means other than a screwdriver

Column V applies to nuts of mantle terminals which are tightened by means other than a screwdriver

Where a screw has a hexagonal head with a slot and the values in columns III and IV are different, the test is made twice, first applying to the hexagonal head the torque specified in column IV, and then, on another set of specimens, applying the torque specified in column III by means of a screwdriver. If the values in columns III and IV are the same, only the test with the screwdriver is made

During the test, terminals shall not work loose and there shall be no damage, such as breakage of screws or damage to the head slots, threads, washers or stirrups, that could impair the further use of the screwed connection.

For mantle terminals, the specified nominal diameter is that of the slotted stud.

The shape of the blade of the test screwdriver must suit the head of the screw to be tested. The screws and nuts shall not be tightened in jerks.

NOTE Screws or nuts which are likely to be operated while the switches are being mounted and connected include terminal screws or nuts, screws for fixing covers, etc.

19.2.5 *Switches having screwed glands are submitted to the following test.*

Screwed glands are fitted with a cylindrical metal rod having a diameter equal to the nearest whole number below the internal diameter of the packing, in millimetres. The glands are then tightened by means of a suitable spanner, the torque specified in table 21 being applied to the spanner for 1 min.

Table 21 – Torque values for screwed glands

Diameter of the test rod mm		*Torque Nm*	
Over	*Up to and including*	*Metal glands*	*Glands of insulating material*
–	*14*	*6,25*	*3,75*
14	*20*	*7,5*	*5,0*
20	–	*10,0*	*7,5*

After the test, neither the glands nor the enclosure of the specimen shall show any damage within the meaning of this standard.

19.2.6 Correct introduction of the screws which are operated during mounting or connection of the switch into the screw holes or nuts shall be ensured.

The requirement of correct introduction is met if introduction of the screw in a slanting manner is prevented, for example, by guiding the screw by the part to be fixed, by a recess in the female thread or by the use of a screw with the leading thread removed.

Compliance is checked by inspection and by manual test.

19.2.7 Screws which make a mechanical connection between different parts of the switch shall be locked against loosening if the connection carries current. Rivets used for current-carrying connections shall be secured against loosening if these connections are subject to torsion in normal use.

Compliance is checked by inspection and by manual test.

Spring washers may provide satisfactory locking. For rivets, a non-circular shank or an appropriate notch may be sufficient.

Sealing compound which softens in heat provides satisfactory locking only for screw connections not being subject to torsion in normal use.

21.1.2 *For parts which are in contact with or support current-carrying parts other than those defined in 21.1.3:*

– *the ball-pressure test 2 of annex E followed by the glow-wire test of annex C carried out at the 650 °C level.*

21.1.3 *For parts which are in contact with, maintain, or retain in position electrical connections including those parts which maintain an electrical connection under spring force, for example a connection within the switch maintained in position by a spring in association with a non-metallic part, the deterioration of which could cause overheating:*

– *the ball-pressure test 2 of annex E followed by the glow-wire test of annex C carried out at the declared level which shall be selected from the following.*

Level 1 – the glow-wire test carried out at 650 °C.

Level 2 – the glow-wire test carried out at 750 °C.

Level 3 – the glow-wire test carried out at 850 °C.

NOTE When selecting the declared level, consideration should be given to the requirements of the relevant appliance or equipment standard. Where an appliance standard gives no indication of the level, reference can be made to IEC 60335-1 for guidance.

21.1.4 *For parts which are in contact with or support heat-sources (for example, heat sinks):*

– *the ball-pressure test 2 of annex E followed by the glow-wire test of annex C carried out at the 650 °C level.*

21.1.5 *For all other parts (except parts unlikely to be ignited or to propagate flames originating from the switch, for which no test is required):*

– *the glow-wire test of annex C carried out at the 650 °C level.*

22 Resistance to rusting

Ferrous parts, the rusting of which might impair safety, shall be adequately protected against rusting.

Compliance is checked by the following test.

All grease is removed from the parts to be tested, by immersion in an appropriate cleaning agent for 10 min. The parts are then immersed for 10 min in a 10 % solution of ammonium chloride in water at a temperature of 25 °C ± 10 °C.

Without drying, but after shaking off any drops, the parts are placed for 10 min in a box containing air saturated with moisture at a temperature of 25 °C ± 10 °C. After the parts have been dried for 10 min in a heating cabinet at a temperature of 100 °C ± 5 °C, their surfaces shall show no signs of rust.

Traces of rust on sharp edges and any yellowish film removable by rubbing are ignored. For small helical springs and the like, and for inaccessible parts exposed to abrasion, a layer of grease may provide sufficient protection against rusting. Such parts are only subjected to the test if there is doubt about the effectiveness of the grease film, and the test is then made without previous removal of the grease.

23 Abnormal operation and fault conditions for electronic switches

Switches shall be constructed so that the risk of fire, mechanical damage impairing safety or protection against electric shock as a result of abnormal condition is prevented.

Compliance is checked by the following tests

- temperature under abnormal conditions according to 23.1,
- protection against electric shock in case of abnormal conditions according to 23 2;
- protection against short circuit according to 23 3,
- protection against failing of cooling according to 23 4

It is acceptable to carry out all tests on the same specimen provided that, with the replacement of an incorporated fuse, the switch is still capable of operation according to the specified rating(s) Otherwise new specimens shall be used

23.1 When switches are operated under abnormal conditions, no part shall reach such a temperature that there is danger of fire to the surroundings of the switches

Compliance is checked by subjecting the switches to a heating test under fault conditions, as described in 23 1 1

During the test, the temperature shall not exceed the values given in tables 13 and 14, second column

23.1.1 *Unless otherwise specified, the tests are made on switches while they are mounted, connected and loaded as specified in 16 3 3*

Each of the abnormal conditions indicated in 23 1 1 1 and 23 1 1 2 is applied in turn

NOTE Other faults may occur during the test, which are a direct consequence

The abnormal conditions are applied in the order which is the most convenient for testing.

23.1.1.1 *The following abnormal conditions shall be simulated*

- *short circuits across creepage distances and clearances, other than those complying with the requirements in clause 20 if they are less than the values given in tables 22 to 24,*
- *short circuits across insulating coating consisting, for example, of lacquer or enamel*

Such coatings are ignored in assessing the creepage distances and clearances

If enamel forms the insulation of a wire, it is considered as contributing 1 mm to those creepage distances and clearances;

NOTE 1 A test for enamelled insulation is under consideration

NOTE 2 The term "coating" does not apply to encapsulation ("potting")

- *short circuit or interruption of semiconductor devices;*
- *short circuit or interruption of capacitors or resistors which do not comply with the requirements of 24.2 or 24.3;*
- *short circuit of the terminals on the load side of cord switches and independently mounted switches.*

Cumulative stress as a result of sequential testing shall be avoided; it will therefore be necessary to use additional specimens. The number of additional specimens should, however, be kept to a minimum by an evaluation of the relevant circuits.

The abnormal conditions are applied one at a time and damages shall be repaired before applying the next abnormal condition.

If an abnormal condition simulated during the test influences other abnormal conditions, all these abnormal conditions are applied simultaneously.

If the temperature of the switch is limited by the operation of automatic protective devices (including fuses), the temperature is measured 2 min after the operation of the device.

If no temperature-limiting device operates, the temperature of switches for continuous duty, duty type S1, is measured after steady state has been reached, or after 4 h, whichever is the shorter time.

For switches for short-time duty, duty type S2, the temperature is measured 2 min after the operation of the switch.

For switches for intermittent periodic duty, duty type S3, the temperature is measured after steady state has been reached, or after 4 h, whichever is the shorter time.

If the temperature is limited by a fuse, the following additional test is carried out:

- *the fuse is short-circuited and the current under the relevant fault conditions is measured;*
- *the switch is then switched on for a duration corresponding to the maximum fusing time of the type of fuse as specified by IEC 60127, corresponding to the current measured above. The temperature is measured 2 min after the end of the period.*

23.1.1.2 *Switches designed to be incorporated or integrated in an appliance shall be tested both as:*

- *switches without automatic protective devices according to 23.1.1.2.1;*
- *switches with automatic protective devices according to 23.1.1.2.2.*

Electronic cord switches and electronic independently mounted switches

- *without incorporated temperature-limiting devices or without incorporated fuses are tested according to 23.1.1.2.1;*
- *protected by automatic protective devices (including other fuses than fuses according to IEC 60127) are tested according to 23.1.1.2.2;*
- *protected by incorporated fuses complying with IEC 60127 are tested according to 23.1.1.2.3;*
- *protected both by incorporated fuses and by automatic protective devices are tested according to 23.1.1.2.4.*

The switch is left in the most unfavourable "ON" position.

23.1.1.2.1 *Switches for continuous duty, duty type S1, are loaded for 1 h with the conventional fusing current for the fuse which in the installation will protect the switch.*

For switches for short-time duty, duty type S2, the temperature is measured 2 min after the operation of the switch

For switches for intermittent periodic duty duty type S3, the temperature is measured after steady state has been reached, or after 4 h, whichever is the shorter time.

The conventional fusing currents to be used for these tests are specified in table 26.

Table 26 – Conventional fusing current versus rated current

Device	Rated current A	Conventional fusing current[1)] A
Cord switches	Up to and including 16	26
Independently mounted switches	Up to and including 16	26
	Over 16 up to and including 32	51
	Over 32 up to and including 63	101
[1)] The values specified originate from IEC 60269-1		

23.1.1.2.2 *Switches for continuous duty duty type S1 are loaded in such a way that the current through the switch measures 0 95 times the current with which the protecting device releases after 1 h*

For switches for short-time duty, duty type S2, the temperature is measured 2 min after the operation of the switch

For switches for intermittent periodic duty, duty type S3 the temperature is measured after steady state has been reached, or after 4 h, whichever is the shorter time

23.1.1.2.3 *The fuses are replaced by links of negligible impedance and shall be loaded in such a manner that the current through the links shall be 2,1 times the rated current of the fuse*

For switches for continuous duty, duty type S1, the temperature is measured after steady state has been reached or after 30 min, whichever is the shorter time

For switches for short-time duty, duty type S2, the temperature is measured 2 min after the operation of the switch.

For switches for intermittent periodic duty, duty type S3, the temperature is measured after steady state has been reached, or after 4 h, whichever is the shorter time

23.1.1.2.4 *The electronic cord switches and electronic independently mounted switches are loaded either as described in 23 1.1.2.3 with incorporated fuse or as described in 23 1 1 2 2 with another automatic protective device, choosing the test requiring the lowest load*

23.2 Protection against electric shock is required, even though a switch is being used or has been used during fault conditions.

Compliance is checked by carrying out the tests described in 23.1.

Having been subjected to the test, the switch shall comply with the requirements of clause 9.

23.3 Electronic cord switches and electronic independently mounted switches shall, without endangering their surroundings, withstand the short circuits they may be subjected to.

Compliance is checked by the following test.

The switch is tested in a substantially non-inductive circuit in series with a load impedance and a device for limiting the let-through I^2t.

The prospective short circuit of the supply shall be 1 500 A r.m.s. at a voltage equal to the rated voltage of the switch under test.

The prospective let-through I^2t value shall be 15 000 A^2s.

NOTE 1 The prospective current is a current that would flow in the circuit if the switch, the limitation device and the load impedance are replaced by links of negligible impedance without any other change in the circuit.

NOTE 2 The prospective I^2t value is a value that would be let through by the limitation device if the switch and the load impedance are replaced by links of negligible impedance. The I^2t value may be limited by using an open wire fuse, an ignitron or other suitable devices.

NOTE 3 The I^2t value of 15 000 A^2s corresponds to an unfavourable let-through I^2t value of 16 A miniature circuit-breakers measured at 1 500 A prospective short-circuit current.

The diagram of the circuit in which the switch is tested is shown in figure 17.

The impedance Z_1 (short-circuit impedance) shall be adjustable to satisfy the specified prospective short-circuit current.

The impedance Z_2 (load impedance) shall be so adjusted that the switch is loaded with its minimum load or with approximately 10 % of the rated load, whichever is the higher.

NOTE 4 A load is necessary for the switch to be in the on-state.

The circuit is calibrated with the following tolerances: current +5 %/0 %, voltage +10 %/0 %, frequency +5 %/0 %, I^2t value ±10 %.

The incorporated fuse, if any, recommended by the manufacturer, is inserted into the switch which is loaded. The variable control, if any, is set at the position of maximum output with any by-pass in open position.

The short circuit is caused six times by the auxiliary switch A without any synchronizing with respect to the voltage wave.

NOTE 5 Six tests are made in view of the need to avoid the complication on point-on-wave timing.

NOTE 6 Experience shows that at least one of these tests will result in near maximum total I^2t.

NOTE 7 Attention is drawn to the fact that solenoid operated pneumatic means may result in an unintentional synchronization.

During the test, emission of flames or burning particles shall not occur.

Enclosed switches are wrapped in tissue paper.

No traces or burn-through shall occur.

NOTE 8 Wrapping tissue as specified in 6.86 of ISO 4046: a soft and strong, lightweight wrapping paper of a grammage generally between 12 g/m² and 30 g/m². It is primarily intended for protective packaging of delicate articles and for gift wrapping.

Unenclosed parts of a partially enclosed switch are tested with dry absorbent surgical cotton placed at a distance of 6 mm – 10 mm from the surface.

Ignition of the cotton shall not occur.

After the test, accessible metal parts shall not be live

It is not necessary for the samples to remain in operating condition. However, the contacts of any incorporated automatic protective device shall not be welded, unless the switch is obviously useless

23.4 Protection against fire in case of failure of cooling

For switches with declared thermal current intended to be used with forced cooling, the switch is mounted and connected as specified in 16.3 2, but without forced cooling during the test

The switch is loaded with the rated current which is continued until steady state is achieved or the switch disconnects the load circuit

During the test, emission of flames or burning particles shall not occur

If it is declared by the manufacturer that the switch will open during this test condition, this function is verified.

24 Components

Components which, if they fail, may cause risk of electric shock or fire (for example, SELV transformers, protective impedances, fuses, capacitors which may cause a shock hazard, and capacitors for electromagnetic interference suppression) shall comply either with the requirements of this standard or with the relevant IEC component standard as far as they reasonably apply

If components are marked with their operating characteristics, the conditions under which they are used in the electronic switch shall be in accordance with these markings, unless a specific exception is made in this standard

The testing of components which have to comply with other standards is, in general, carried out separately, according to the relevant standard as follows.

If the component is marked and used in accordance with its marking, the number of samples is that required by the relevant standard.

Where no IEC standard exists or when the component has not been tested in accordance with a relevant IEC standard, or is used not in accordance with its specified ratings, the component is tested under the conditions occurring in the electronic switch

Components incorporated in the electronic switch are subjected to all the tests of this standard as a component of the electronic switch.

NOTE Compliance with the IEC standard for the relevant component does not necessarily ensure compliance with the requirements of this standard.

24.1 Protective devices

Protective devices shall be in accordance with the relevant IEC publications and/or the additional requirements specified in the following subclauses:

- 24.1.1 fuses;
- 24.1.2 cut-outs;
- 24.1.3 protective devices which only decrease the current;
- 24.1.4 fusing resistors.

24.1.1 Fuses

Fuses, if any, shall comply with IEC 60127-2 or IEC 60269-3-1 and have a rated breaking capacity of at least 1 500 A unless any fault current through the fuse is limited to the breaking capacity of the fuse.

24.1.2 Cut-outs

Cut-outs shall have adequate making and breaking capacity, be selected for the appropriate number of operations and be in compliance with the requirements and test specifications in the following subclauses:

- 24.1.2.1 non-resettable cut-outs;
- 24.1.2.2 resettable, non-self-resetting cut-outs;
- 24.1.2.3 self-resetting cut-outs.

Compliance is checked by subjecting three specimens to the tests according to the following general test specification and the additional tests specified for the relevant type.

If the cut-out in the electronic switch is subjected to a reference temperature outside the range 0 °C to 35 °C or 55 °C (according to 7.1.3.4.2 or 7.1.3.2 and 7.1.3.3), the samples are tested at this reference temperature.

During the test, the other conditions shall be similar to those occurring in the electronic switch.

During the test, no sustained arcing shall occur.

After the test, the specimens shall show no damage impairing their further use or the safety of the electronic switch.

The switching frequency of the cut-out may be increased above the normal switching frequency inherent to the electronic switch, provided that no greater risk of failure of the cut-out is induced.

If it is not possible to test the cut-out separately, it will be necessary to submit additional specimens of the electronic switch in which the cut-out is used.

24.1.2.1 Non-resettable cut-outs

Non-resettable cut-outs shall be thermal links in accordance with IEC 60691 or bi-metallic single operation devices (SOD) according to IEC 60730-2-9

Compliance is checked by the tests according to 24.1.2

After the test, the supply shall be cut out and the temperature shall neither exceed the maximum temperatures specified by the manufacturer or the values in table 13 for abnormal conditions

24.1.2.2 Resettable, non-self-resetting cut-outs

Resettable, non-self-resetting cut-outs shall be in accordance with IEC 60730-1 and appropriate parts 2

Compliance is checked by the tests according to 24 1 2 and the following additional tests

Resettable, non-self-resetting cut-outs in the load circuit of the electronic switch are tested at 1,1 times the rated voltage of the electronic switch and with loads as specified below

The cut-outs are reset after each operation and thus caused to operate 10 times successively

- *Cut-outs in electronic switches for incandescent lamps are tested in a non-inductive circuit and are loaded with the conventional fusing current of the protecting fuse;*
- *Cut-outs in electronic switches for speed control circuits are subjected to two series of 10 operations*
  - *In the first series, the cut-out under test closes a circuit through which a current of 9 I_n (cos φ = 0,8 ± 0,05) passes, this current being interrupted by means of an auxiliary switch 50 ms to 100 ms after each closure*
  - *In the second series, the circuit through which a current of 6 I_n (cos ω = 0,6 ± 0,05) passes is closed by an auxiliary switch and opened by the cut-out under test*
- *Cut-outs for other types of load are tested with the opening and closing current declared by the manufacturer*

NOTE 1 The values 6 I_n and 9 I_n are provisional

NOTE 2 "I_n" is the rated current of the electronic switch. If the electronic switch has a rated load instead of a rated current, I_n is calculated under the assumption that cos ω of the motor load is 0 6

24.1.2.3 Self-resetting cut-outs

Self-resetting cut-outs shall be in compliance with IEC 60730

Compliance is checked by the tests according to 24.1 2 and the following additional tests.

Self-resetting cut-outs in the load circuit of the electronic switch are tested at 1,1 times the rated voltage of the electronic switch and with loads as specified below.

- *cut-outs in electronic switches for incandescent lamps are operated automatically for 200 cycles in a non-inductive circuit and are loaded with the relevant conventional fusing current of the protecting fuse.*

NOTE Cut-outs in electronic switches for other types of load are tested as declared by the manufacturer

24.1.3 Protective devices which only decrease the current (for example PTC resistors)

Protective devices which only decrease the current shall be of a thermistor type according to annex J in IEC 60730-1 or PTC-S thermistors according to IEC 60738-1.

Compliance is checked by the tests according to 24.1.2 and the following additional tests.

For PTC-S thermistors, the power dissipation of which exceeds 15 W for the rated zero-power resistance at an ambient temperature of 25 °C, the encapsulation or tubing shall comply with the flammability category FV1 or better according to IEC 60707.

Compliance with the flammability criteria is checked according to IEC 60707.

24.1.4 Fusing resistors

Fusing resistors shall have adequate breaking capacity and shall not cause emission of flames or burning particles during rupture under fault conditions.

In case of doubt, the test is repeated on a new sample of the same resistor. If again the resistor interrupts in the same way it is accepted as a fusing resistor for protection against the relevant fault condition.

24.2 Capacitors

Capacitors

- which may cause a shock or fire hazard and capacitors for electromagnetic interference,
- the short-circuiting or disconnection of which would cause an infringement of the requirements under fault conditions with regard to shock or fire hazard,
- the short-circuiting of which would cause a current >0,5 A through the terminals of the capacitor

shall comply with the requirements of IEC 60384-14 and shall be in accordance with table 27.

The duration of the damp-heat, steady-state test as specified in 4.12 of IEC 60384-14, shall be 21 days.

When determining the current, fuses are to be considered short-circuited. For other protective devices, the resistive element is to be replaced by an equivalent impedance.

Table 27 – Requirements for capacitors

Application of capacitors	Types of capacitors (according to IEC 60384-14)		
		125 V < U_n ≤ 250 V	
	U_n ≤ 125 V	Without overcurrent protection[1)]	With overcurrent protection[1)]
Between live conductor (L or N) and earth (PE)	Y4	Y2	Y2
Between live conductors (L and N or L1 and L2)			
– without impedance in series	X2	X1	X2
– with impedance in series which, by short-circuiting of the capacitor, limits the current to a value			
• of 0 5 A and higher	X3	X2	X3
• below 0 5 A	No special requirement	No special requirement	No special requirement

1) Fusing resistor (built-in or external)

24.3 Resistors

Resistors, the short-circuiting or interrupting of which would, in case of a defect, cause an infringement of the requirements with regard to the protection against fire and electric shock, shall have an adequately constant value under overload conditions prevailing in the electronic switch

25 EMC requirements

Switches for appliances shall fulfil the requirements for immunity and emission when used in accordance with the manufacturer's specification

Electronic switches intended to be built in or incorporated in an appliance shall comply with the requirements for immunity and emission of the end product

Compliance is checked with the electronic switch incorporated or integrated in the appliance

NOTE Electronic switches intended to be built in or incorporated in an appliance are only tested if requested by the manufacturer

Electronic cord switches and independently mounted switches shall fulfil the requirements for immunity and emission when used in accordance with the manufacturer's declaration

Compliance is checked by 25 1 and 25 2 with the electronic cord switch or independently mounted switch tested as a separate device or together with the relevant appliance

25.1 Immunity

Mechanical switches within the scope of this standard are not affected by electromagnetic disturbances, and, therefore, no immunity tests are necessary.

Electronic switches shall be designed so that the switch state (on or off) and/or setting value is protected against electromagnetic interference.

For the following tests the electronic switch is mounted as in normal use and is loaded as specified in clause 17 so that at the rated voltage the rated load will be obtained.

Each electronic switch is tested, if applicable, in the following states:

a) in the ON state, highest setting;

b) in the ON state, lowest setting;

c) in the OFF state, highest setting;

d) in the OFF state, lowest setting.

25.1.1 Voltage dips and short interruptions

The electronic switch shall be tested with the test equipment specified in IEC 61000-4-11 as specified in 25.1 in accordance with table 28 with a sequence of three dips/interruptions with intervals of 10 s minimum (between each test event).

Abrupt changes in supply voltage shall occur at zero crossings. The output impedance of the test voltage generator shall be low, even during the transition.

The change between the test voltage U_T and the changed voltage is abrupt.

NOTE 100 % U_T is equal to the rated voltage.

A test level of 0 % corresponds to a total supply voltage interruption.

Table 28 – Test levels and duration for voltage dips and short interruptions

Test level % U_T	Voltage dip/interruptions % U_T	Duration number of cycles at rated frequency Cycles
0	100	10
40	60	10
70	30	10

During the test, the electronic switch state and/or setting may alter.

Occasional flickering of luminaires and irregular running of motors during the test are neglected.

After the test, the electronic switch shall be in the original state and the setting shall be unchanged.

25.1.2 Withstand to 1,2/50 wave impulses

NOTE If the electronic switch is intended to be used with different kinds of load, the most severe load(s) should be chosen for these tests

The tests are carried out according to IEC 61000-4-5 with an open-circuit test voltage of 1 kV (level 2).

During the tests, the switch state and/or setting shall not alter.

Occasional flickering of luminaires and irregular running of motors during the test are neglected.

After the tests the electronic switch shall be in the original state and the setting shall be unchanged.

25.1.3 Electrical fast transient test

The electronic switch shall be subjected to repetitive fast transients (bursts) on supply and control terminals/terminations

The test is carried out according to IEC 61000-4-4 with the following specification

The level of the repetitive fast transients consisting of bursts coupled into supply and control terminals/terminations of the electronic switch is in accordance with table 29

Table 29 – Fast transient bursts

Open circuit output test voltage ±10 %	
Supply terminals/terminations	Control terminals/terminations
1 kV (level 2)	0,5 kV (level 2)

Both polarities of the test voltage are mandatory

The duration of the test shall be not less than 1 min

During the test, the electronic switch state and/or setting may alter

Occasional flickering of luminaires and irregular running of motors during the test are neglected.

After the test, the switch shall remain in its original state

NOTE If any change of the setting occurs, it should be possible to restore the setting by operation of the control(s)

25.1.4 Electrostatic discharge test

The electronic switch mounted as in normal use shall withstand electrostatic contact and air discharges.

The test is carried out according to IEC 61000-4-2 by applying one positive and one negative discharge, of both types (air/contact), if necessary, to each of the 10 preselected points designated by the manufacturer.

The following levels apply:

- *test voltage of contact discharge: 4 kV;*
- *test voltage of air discharge: 8 kV.*

During the test, the switch state and/or setting may alter.

Occasional flickering of luminaires and irregular running of motors during the test are neglected.

After the test, the electronic switch shall remain in its original state.

NOTE 1 If any change of the setting occurs, it should be possible to restore the setting by operation of the control(s).

NOTE 2 Certain electronic switches (for example, passive infrared switches – "PIR switches") with adjustable time delay devices should be adjusted in such a way that the delay time is higher than the testing time.

NOTE 3 Measured values within the test limits are acceptable for the results until the situation on uncertainty measurements has been clarified.

25.1.5 Radiated electromagnetic field test

The electronic switch subjected to electromagnetic fields such as those generated by portable radio transceivers or any other device that will generate continuous wave radiated electromagnetic energy shall be tested as follows.

The test is carried out according to IEC 61000-4-3, applying a field strength of 3 V/m.

NOTE It is under consideration to replace the tests according to IEC 61000-4-3 by tests according to IEC 61000-4-6.

After the test, the electronic switch shall be in the original state and the setting shall be unchanged.

During the test, the electronic switch state and/or setting may alter; other changes are not acceptable.

Occasional flickering of luminaires and irregular running of motors during the test are neglected.

25.2 Emission

For mechanical switching devices within the scope of this standard electromagnetic disturbances may only be generated during switching operations. Since this is not continuous, no emission tests are necessary.

25.2.1 Low-frequency emission

Electronic switches intended to be connected to the public low-voltage supply systems shall be so designed that they do not cause excessive disturbances in this network.

Compliance is checked by carrying out tests according to IEC 61000-3-2 and IEC 61000-3-3 or IEC 61000-3-5.

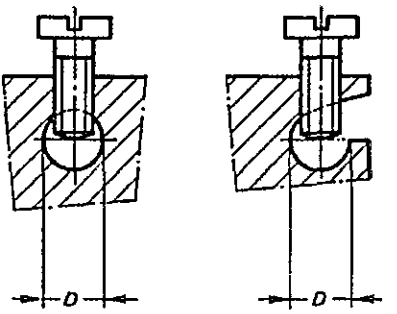
Requirements are deemed to be met if the electronic switch complies with the criterias specified in these standards, except that for harmonics of order 11, an overview of the spectrum is taken.

If this overview shows an envelope of the spectrum with a monotonal decrease according to the increasing order of harmonics, measurements can be restricted to harmonics up to order 11.

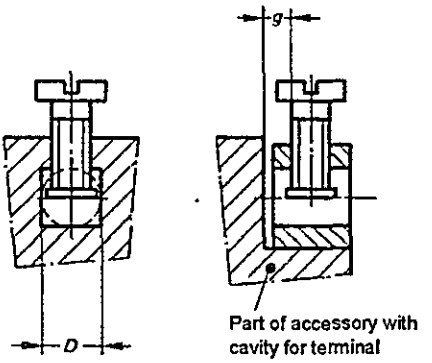
25.2.2 Radio-frequency emission

Electronic switches shall be so designed that they do not cause excessive radio interference

Compliance tests are under consideration.



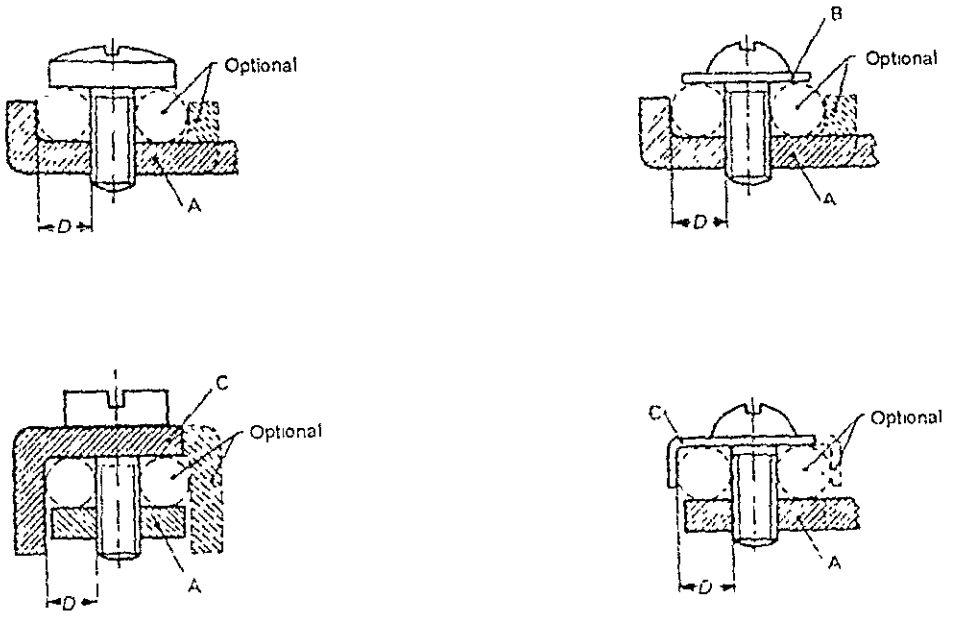
1a – Terminals without pressure plates



1b – Examples of pillar terminals

D conductor space (not specified)
g distance between clamping screw and end-stop (not specified)

Figure 1 – Examples of pillar terminals



2a – Screw terminals

2b – Stud terminals

A fixed part
B washer or clamping plate
C anti-spread device
D conductor space (not specified)
F stud

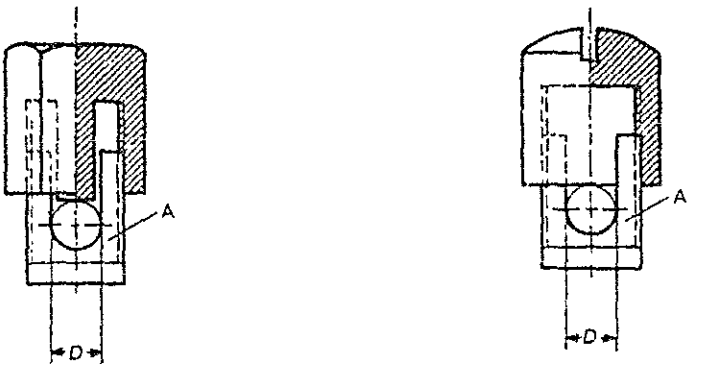
Figure 2 – Examples of screw terminals and stud terminals

A saddle
B cable lug or bar
C stud
D conductor space (not specified)

Figure 3 – Examples of saddle terminals

A locking means
B cable lug or bar
E fixed part
F stud

Figure 4 – Examples of lug terminals



A fixed part

D conductor space (not specified)

The bottom of the conductor space shall be slightly rounded in order to obtain a reliable connection.

Figure 5 – Examples of mantle terminals

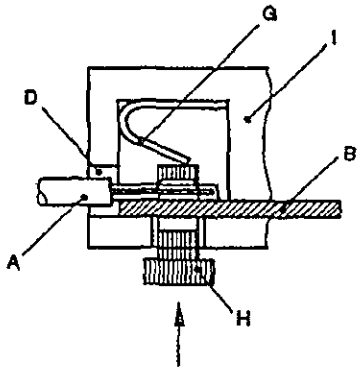


Figure 6a – Screwless terminal with indirect pressure clamping means and loosening with an actuating element

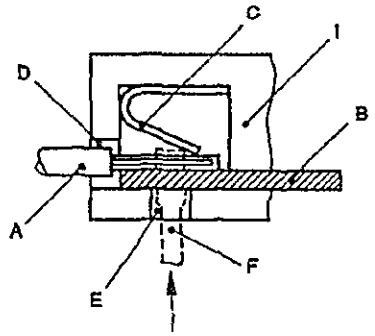


Figure 6b – Screwless terminal with direct pressure clamping means and loosening with a tool

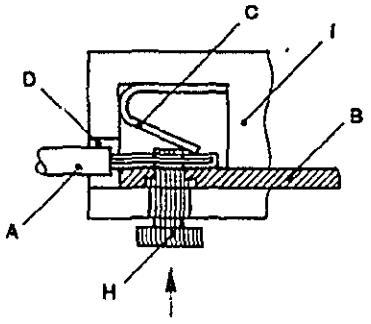
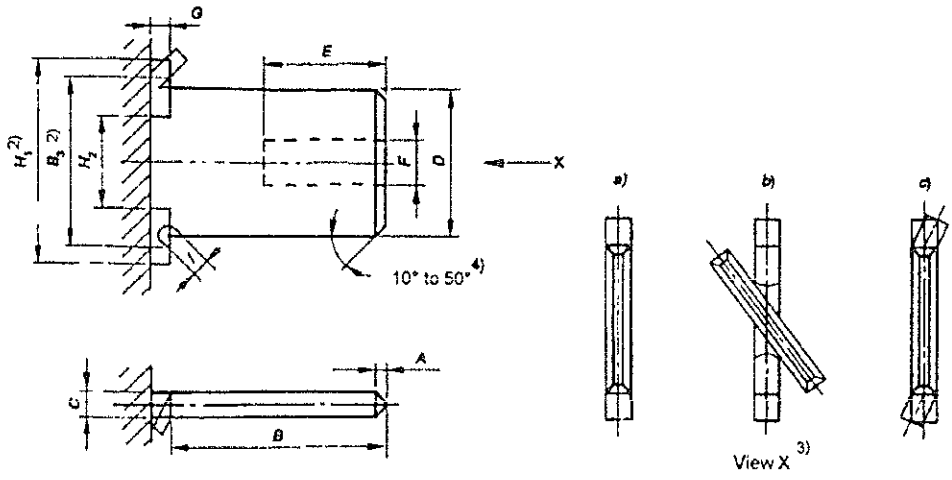


Figure 6c – Screwless terminal with direct pressure clamping means and loosening with an actuating element

A	conductor	F	tool (screwdriver)
B	current-carrying part	G	pressure-spring
C	clamping spring	H	actuating element
D	conductor opening	I	part of the switch
E	tool opening		

Figure 6 – Examples of screwless terminals



Dimensions of tabs[5]

Dimensions in millimetres

Nominal size	A (Mandatory) Max	B (Mandatory) Min	C (Mandatory) +0,04 −0,03	D (Mandatory) +0,1 −0,1	E (Optional) Max	F (Optional) Max	G (Mandatory) Min	H_2 (Mandatory) Min	I (Optional) Diameter Max
2,8 × 0,5	0,7	7,0	0,5	2,8	2,5	1,5	1,2	1,8	0,6
2,8 × 0,8	0,7	7,0	0,8	2,8	2,5	1,5	1,2	1,8	0,6
4,8 × 0,5 1)	1,2	6,2	0,5	4,7	4,2	1,6	1,2	3,0	1,0
4,8 × 0,8	1 2	6,2	0,8	4,7	4,2	1 6	1 2	3,0	1,0
6,3 × 0,8	1,3	7,8	0,8	6,3	5,7	2,0	1,2	4,0	1,3
9,5 × 1,2	1,3	12,0	1,2	9,5	6,5	2,0	1,2	6,2	1,8

1) Nominal size 4,8 × 0,5 is not recommended for new design

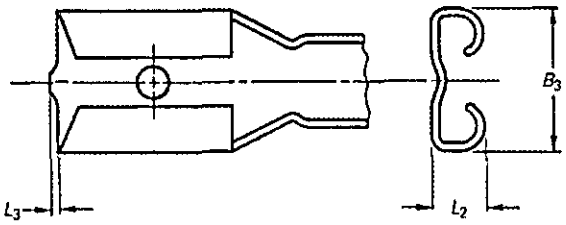
2) Dimensions "B_3" and "H_1" not specified

3) View "X" shows examples a) to c) of different possible methods of fixation

4) The end of the tab is shaped to facilitate the application of the female connector

5) Tabs manufactured according to the dimensions of figure 7 will be compatible with female connectors manufactured according to IEC 60760. For push-on and pull-off forces, refer to annex H

Figure 7 – Tabs of flat quick-connect terminations



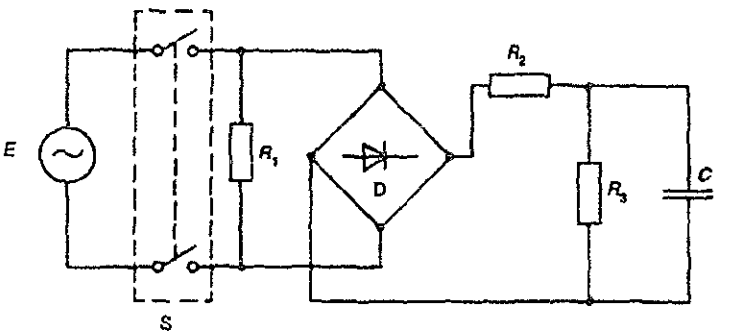
Dimensions of female connectors

Dimensions in millimetres

Connector for tab size	B_3 Max.	L_2 Max.	L_3 Max.
2,8 × 0,5	3,8	2,3	0,5
2,8 × 0,8	3,8	2,3	0,5
4,8 × 0,5 [1)]	6,0	2,9	0,5
4,8 × 0,8	6,0	2,9	0,5
6,3 × 0,8	7,8	3,5	0,5
9,5 × 1,2	11,1	4,0	0,5

1) Nominal size 4,8 × 0,5 is not recommended for new design.

Figure 8 – Female (test) connector of flat quick-connect termination



$R_1 = E / I$ where E is the rated voltage and I is the rated resistive current or the rated current of the lamp;

$R_2 = R_1 \times 1{,}414 / (X - 1)$ where X is the ratio between the peak surge current and the rated resistive current, or the ratio of the peak inrush current of the cold lamp and the rated current of the lamp,

$R_3 = (800/X) \times R_1$

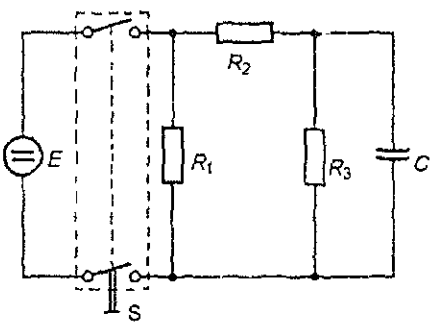
$C \times R_2 = 2\,500\ \mu s$

D silicon rectifier-bridge

S specimen

The circuit elements and the source impedance are chosen so as to ensure a 10 % accuracy of the surge current the peak inrush current of the cold lamp, the rated resistive current, or the rated current of the lamp.

Figure 9a – Circuit for capacitive load test and simulated tungsten filament lamp load test for a.c. circuits



$R_1 = E / I$ where E is the rated voltage and I is the rated resistive current or the rated current of the lamp;

$R_2 = R_1 / (X - 1)$ where X is the ratio between the peak surge current and the rated resistive current, or the ratio of the peak inrush current of the cold lamp and the rated current of the lamp,

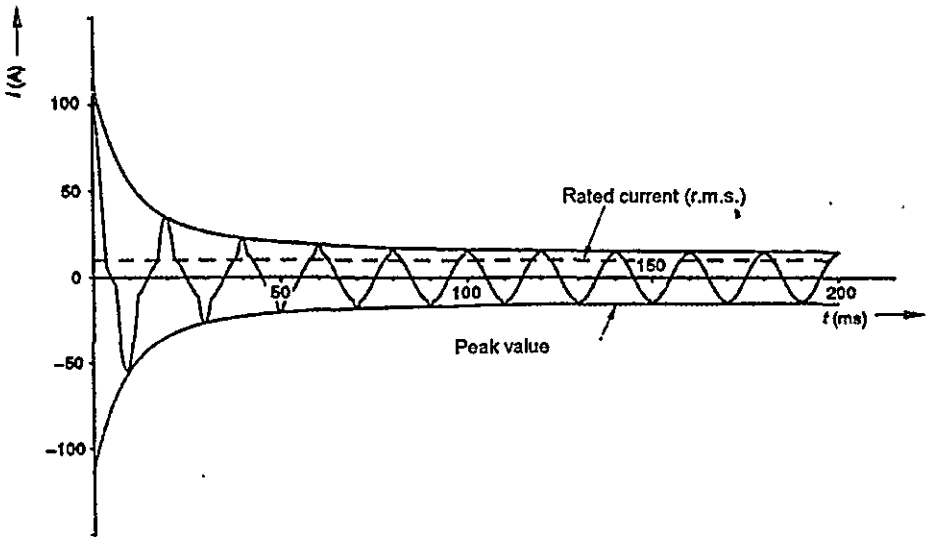
$R_3 = (800/X) \times R_1$

$C \times R_2 = 2\,500\ \mu s$

S specimen

The circuit elements and the source impedance are chosen so as to ensure a 10 % accuracy of the surge current, the peak inrush current of the cold lamp, the rated resistive current, or the rated current of the lamp

Figure 9b – Circuit for capacitive load test and simulated lamp load test for d.c. circuits



List of values

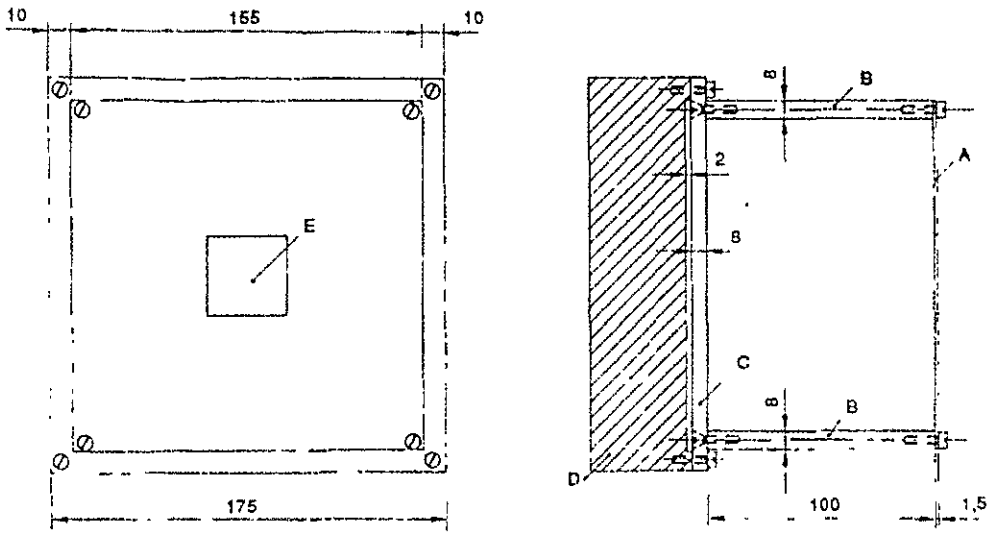
R_1 = 25 Ω

R_2 = 3,93 Ω

R_3 = 2 000 Ω

C = 636 µF

Figure 10 – Values of the capacitive load test circuit for test of switches rated 10/100 A 250 V~



A interchangeable steel plate with a thickness of 1,5 mm

B aluminium plate with a thickness of 8 mm

C sheet of plywood with a thickness of 8 mm

D mounting-support of steel with a mass of 10 kg ± 1 kg

E cut-out in the steel plate for the specimen

Dimensions in millimetres

Figure 11 – Mounting device for the impact test

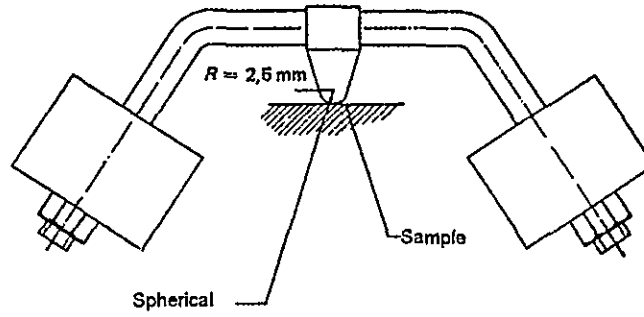
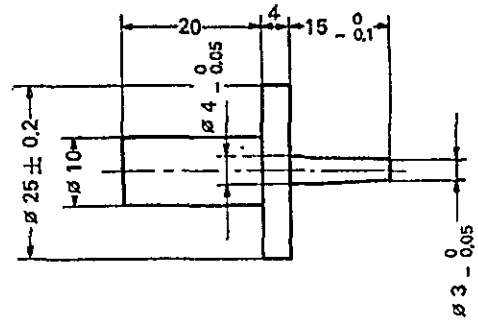
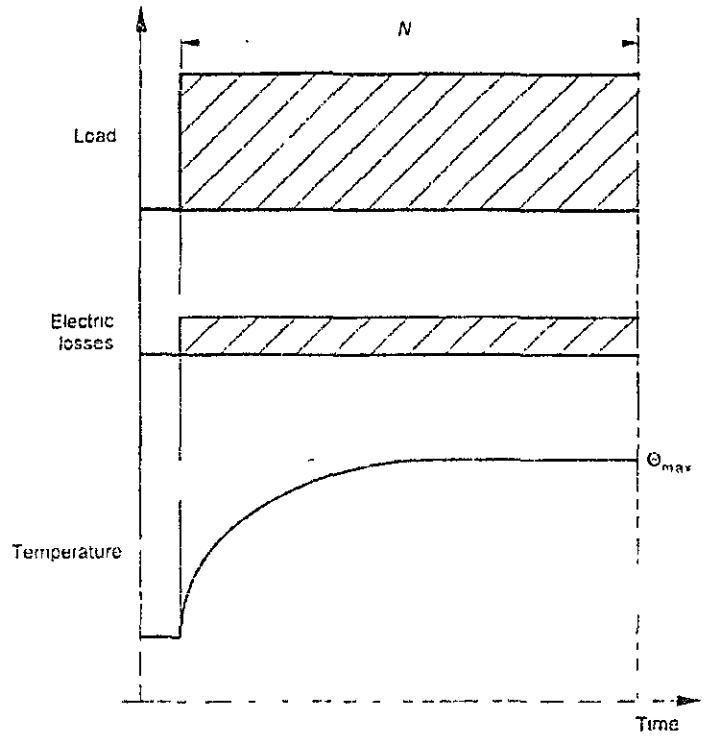


Figure 12 – Ball pressure apparatus



Dimensions in millimetres

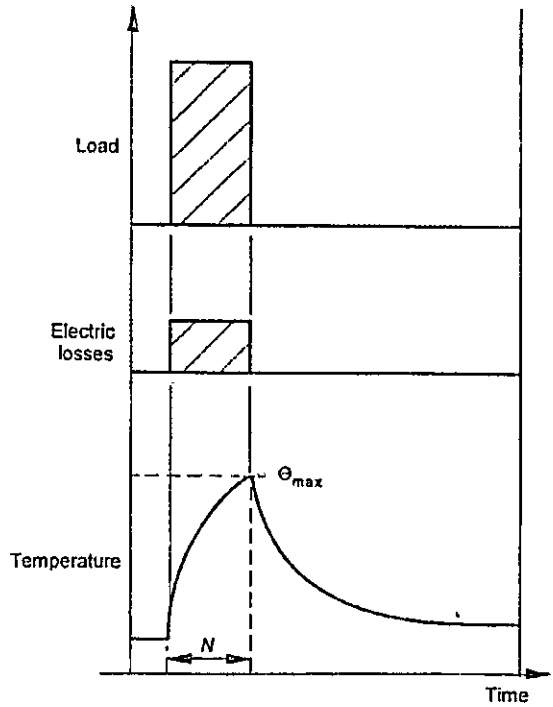
Figure 13 – Test pin



N Operation at constant load

Θ_{max} Maximum temperature attained

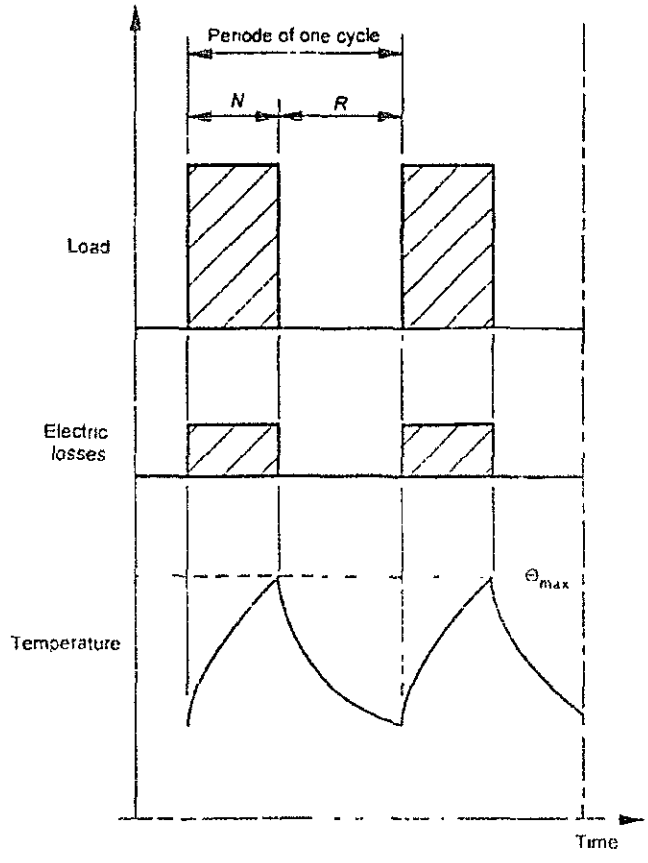
Figure 14 – Continuous duty – Duty type S1 (see 7 1 16.1)



N Operation at constant load

Θ_{max} Maximum temperature attained

Figure 15 – Short-time duty – Duty type S2 (see 7.1.16.2)

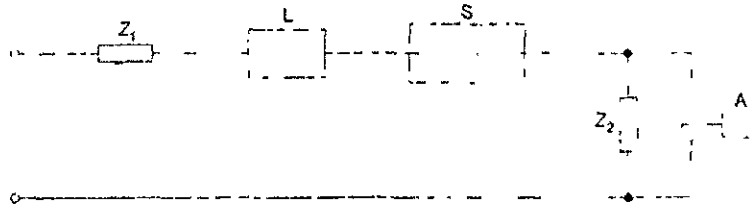


N Operation at constant load

R At rest and de-energized

Θ_{max} Maximum temperature attained

Figure 16 – Intermittent periodic duty – Duty-type S3 (see 7.1.16.3)



A Auxiliary switch for causing the short circuit

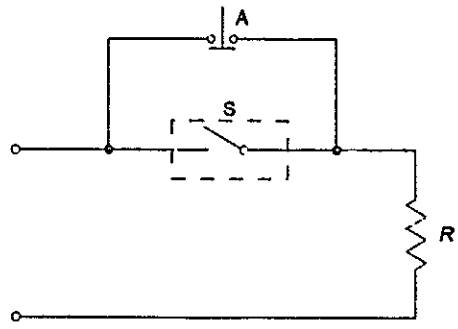
L Limiting device for the let-through I^2t

S Specimen

Z_1 Impedance for adjusting the prospective short-circuit current (non-inductive)

Z_2 Impedance for adjusting the load (non-inductive)

Figure 17 – Diagram for short-circuit test

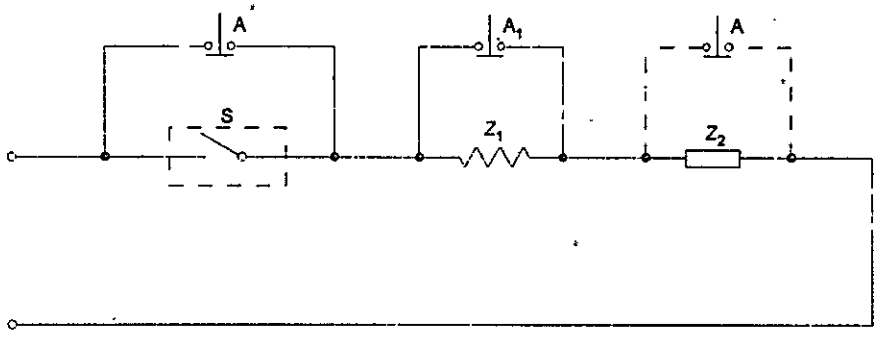


A Auxiliary switch to set switch load

R Resistive load to attain current

S Test specimen

Figure 18 – Diagram for heating test



A Auxiliary switch to set switch load

A_1 Auxiliary switch to attain "break" current

S Test specimen

Z_1 Resistive load to attain "break" current

Z_2 Load for "make" current

The "make" test load is set by closing the auxiliary switches A and A_1 and adjusting Z_2.

The "break" test load is set by closing the auxiliary switch A and adjusting Z_1 with the auxiliary switch A_1 open-circuited.

Throughout the electrical endurance test, the auxiliary switch A is open-circuited.

A_1 is initially closed and is open-circuited time-delayed after the test specimen closes, to reduce the "make" test load to the break load. After the test, the specimen S switches off, and the auxiliary switch A_1 is closed before the next operation of the test specimen.

For the test of electrical contacts, the delay time shall be 50 ms to 100 ms. For the test of electronic switches, where the phase angle of the switched load voltage varies with the movement of the actuating member, the delay time is chosen in such a way that, depending on the operating speed of the actuating mechanism of the test equipment, A_1 is open-circuited at maximum phase angle.

NOTE Some simulated loads, for example 12(2) A, will require auxiliary additional switches in order to set the correct break load.

Figure 19 – Diagram for endurance test

Annex A
(normative)

Measurement of clearances and creepage distances

The width *X* specified in examples 1 to 11 apply to all examples as a function of the pollution degree as follows.

	Width *X*
Pollution degree	Minimum values
1	0,25 mm
2	1,0 mm
3	1,5 mm

If the associated clearance is less than 3 mm, the minimum width *X* may be reduced to one-third of this clearance

The methods of measuring creepage distances and clearances are indicated in the following examples 1 to 11. These cases do not differentiate between gaps and grooves or between types of insulation

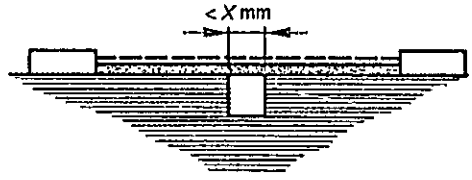
The following assumptions are made:

- any recess is assumed to be bridged with an insulating link having a length equal to the specified width *X* and being placed in the most unfavourable position (see example 3),
- where the distance across a groove is equal to or larger than the specified width *X*, the creepage distance is measured along the contours of the groove (see example 2);
- creepage distances and clearances measured between parts which can assume different positions in relation to each other, are measured when these parts are in their most unfavourable position

Explanation for examples 1 to 11

_____ clearance

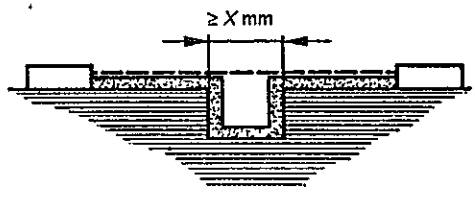
_____ creepage distance



Example 1

Condition: Path under consideration includes a parallel- or converging-sided groove of any depth with a width less than "X" mm.

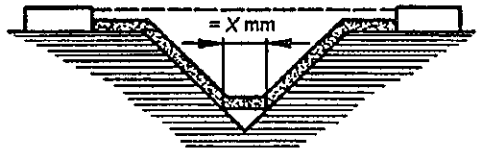
Rule: Creepage distance and clearance are measured directly across the groove as shown.



Example 2

Condition: Path under consideration includes a parallel-sided groove of any depth and with a width equal to or more than "X" mm.

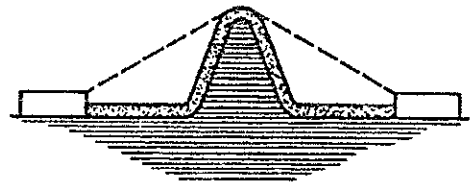
Rule: Clearance is the "line-of-sight" distance. Creepage path follows the contour of the groove.



Example 3

Condition: Path under consideration includes a V-shaped groove with a width greater than "X" mm.

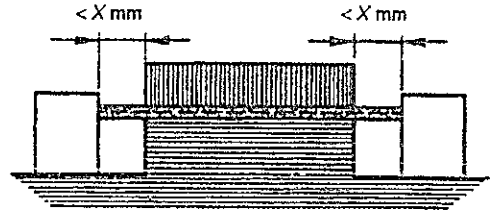
Rule: Clearance is the "line-of-sight" distance. Creepage path follows the contour of the groove but "short-circuits" the bottom of the groove by an "X" mm link.



Example 4

Condition. Path under consideration includes a rib.

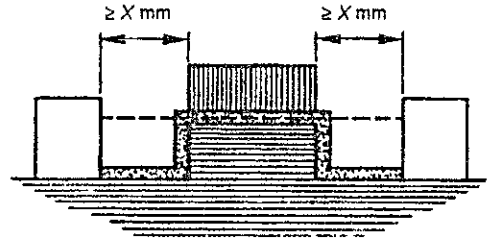
Rule: Clearance is the shortest direct air path over the top of the rib Creepage path follows the contour of the rib.



Example 5

Condition: Path under consideration includes an uncemented joint with grooves less than "*X*" mm wide on each side

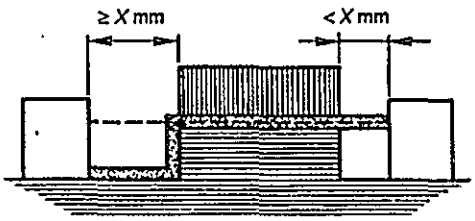
Rule: Creepage and clearance path is the "line-of-sight" distance shown.



Example 6

Condition: Path under consideration includes an uncemented joint with grooves equal to or more than "*X*" mm wide on each side.

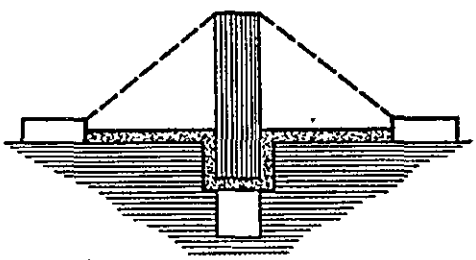
Rule: Clearance is the "line-of-sight" distance. Creepage path follows the contour of the grooves.



Example 7

Condition: Path under consideration includes an uncemented joint with a groove on one side less than "X" mm wide and the groove on the other side equal to or more than "X" mm wide.

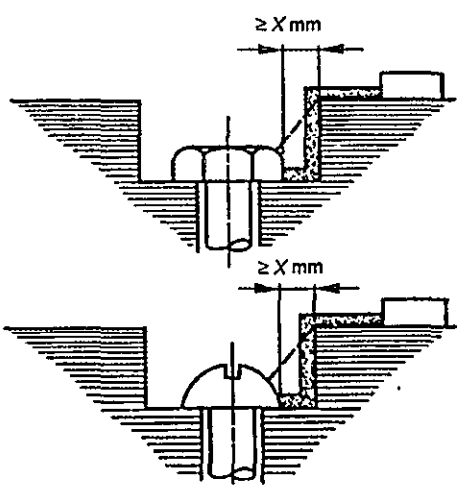
Rule: Clearance and creepage paths are as shown.



Example 8

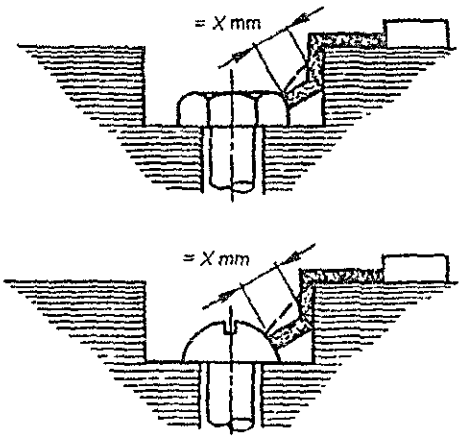
Condition: Creepage distance through an uncemented joint is less than creepage distance over a barrier.

Rule: Clearance is the shortest direct air path over the top of the barrier.



Example 9

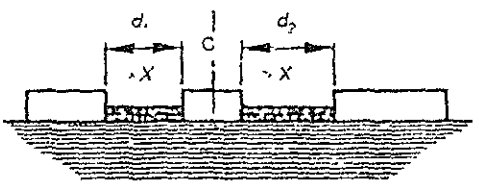
Gap between head of screw and wall of recess wide enough to be taken into account.



Example 10

Gap between head of screw and wall of recess too narrow to be taken into account.

Measurement of creepage distance is from screw to wall when the distance is equal to "X" mr



Example 11

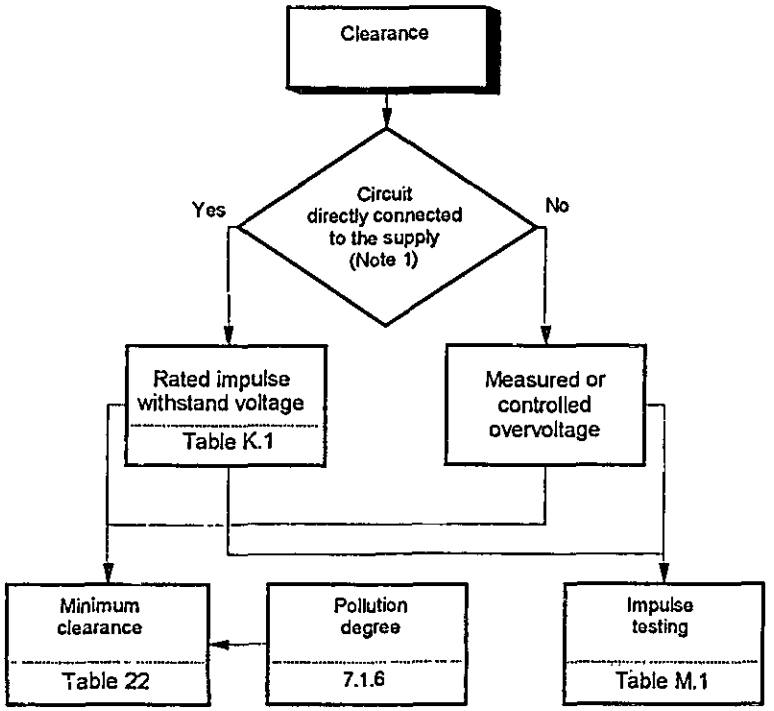
C floating part

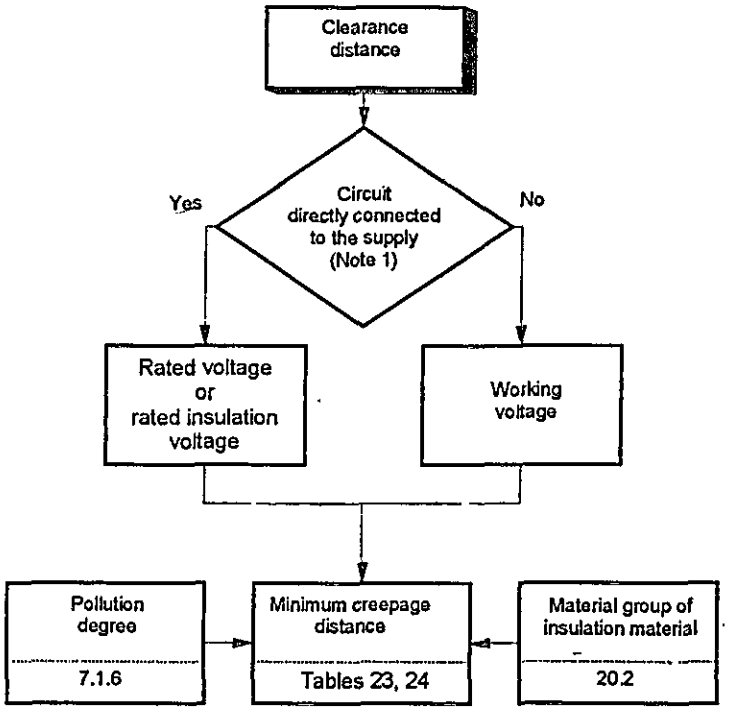
Clearance is the distance $d_1 + d_2$

Creepage distance is also $d_1 + d_2$

Annex B
(informative)

Diagram for the dimensioning of clearances and creepage distances





NOTE Includes all circuits significantly affected by external transient overvoltages.

Annex D
(normative)

Proof tracking test

The proof tracking test (PTI) is carried out in accordance with IEC 60112.

For the purpose of this standard, the following applies:

a) *In clause 3, test specimen, the last sentence of the first paragraph does not apply.*

   Moreover, notes 2 and 3 also apply to the proof tracking test of 6.3.

   NOTE If the surface 15 mm × 15 mm cannot be obtained, because of the small dimensions of the switches, special specimens made with the same manufacturing procedure may be used.

b) *The test solution "A" described in 5.4 shall be used.*

c) *If the test is carried out with electrodes of materials other than platinum, this shall be reported.*

d) *The tolerance on the interval between drops shall be ±1 s.*

e) *In clause 6, procedure, the voltage referred to in 6.1 is set to the value as determined from 20.2 of this standard dependent on the material group taken from table 23 or table 24 of this standard for the measured creepage distance considering the declared pollution degree and the voltage (rated voltage) expected to occur in normal use. Moreover, 6.2 does not apply and the proof tracking test of 6.3 shall be performed on five specimens.*

Annex E
(normative)

Ball-pressure test

E.1 Ball-pressure test 1

E.1.1 Test specimen

The surface of the part to be tested is placed in the horizontal position. The thickness of the specimen shall not be less than 2,5 mm; if necessary, two or more layers of the part subjected to the test shall be used.

E.1.2 Preconditioning

The parts to be tested are stored for 24 h in an atmosphere having a temperature between 15 °C and 35 °C and a relative humidity between 45 % and 75 %, before starting the test.

E.1.3 Test apparatus

The test apparatus is shown in figure 12.

E.1.4 Test procedure

The ball is applied to the surface of the part to be tested placed in a horizontal position.

The specimen is supported on a 3 mm thick steel plate.

A steel ball of 5 mm diameter is pressed against the surface of the specimen by a force of 20 N.

The test is made in a heating cabinet at a temperature of 20 °C ± 2 °C plus the value of the maximum temperature measured during the heating tests of 16.3, or as declared, or at 75 °C ± 2 °C, whichever is the highest

The support and the ball shall be at the prescribed test temperature before the test is started.

After 1 h, the ball is removed from the specimen which is then cooled down to approximately room temperature by immersion for 10 s in cold water

E.1.5 Observations and measurements

The diameter of the impression caused by the ball is measured and shall not exceed 2 mm.

NOTE The test is not made on parts of ceramic material.

E.2 Ball-pressure test 2

This test is equal to ball-pressure test 1 with the exception that the temperature of the heating cabinet shall be Tb ± 2 °C, where Tb is equal to T + 20 °C with a minimum value of 125 °C or 20 °C in excess of the maximum temperature recorded during the heating test of 16.3 if this would lead to a higher temperature.

Annex F
(informative)

Switch application guide

F.1 In actual applications switches control many different types of circuits throughout a broad range of currents. It is not economically feasible to test every switch on every application load. For the purpose of testing for certification, standard test circuit conditions have been established which are representative of typical circuits in the application. The electrical ratings of the switch are then verified using the standard circuit conditions. The following guidelines may be used for determining whether a particular switch rating is suitable for controlling the circuit in the actual application.

F.1.1 Resistive load current ratings

The resistive load current rating is established using a substantially resistive load with a power factor not less than 0,95.

F.1.1.1 Switches with resistive load rating may be used to control a motor load provided

- the power factor is not less than 0,8 and the motor load current does not exceed 60 % of the resistive load current rating of the switch and the inrush current value does not exceed the resistive load value, or
- the power factor is not less than 0,6 and the motor load current does not exceed 16 % of the resistive load current rating of the switch.

F.1.1.2 Switches with resistive load rating may be used to control a tungsten filament lamp load, provided the steady-state current of the tungsten filament lamp load does not exceed 10 % of the resistive load current rating of the switch.

F.1.2 Resistive and/or motor load current ratings

The motor load current rating is established using a load with a power factor of 0,6 for making the circuit and a power factor of 0,95 for breaking the circuit.

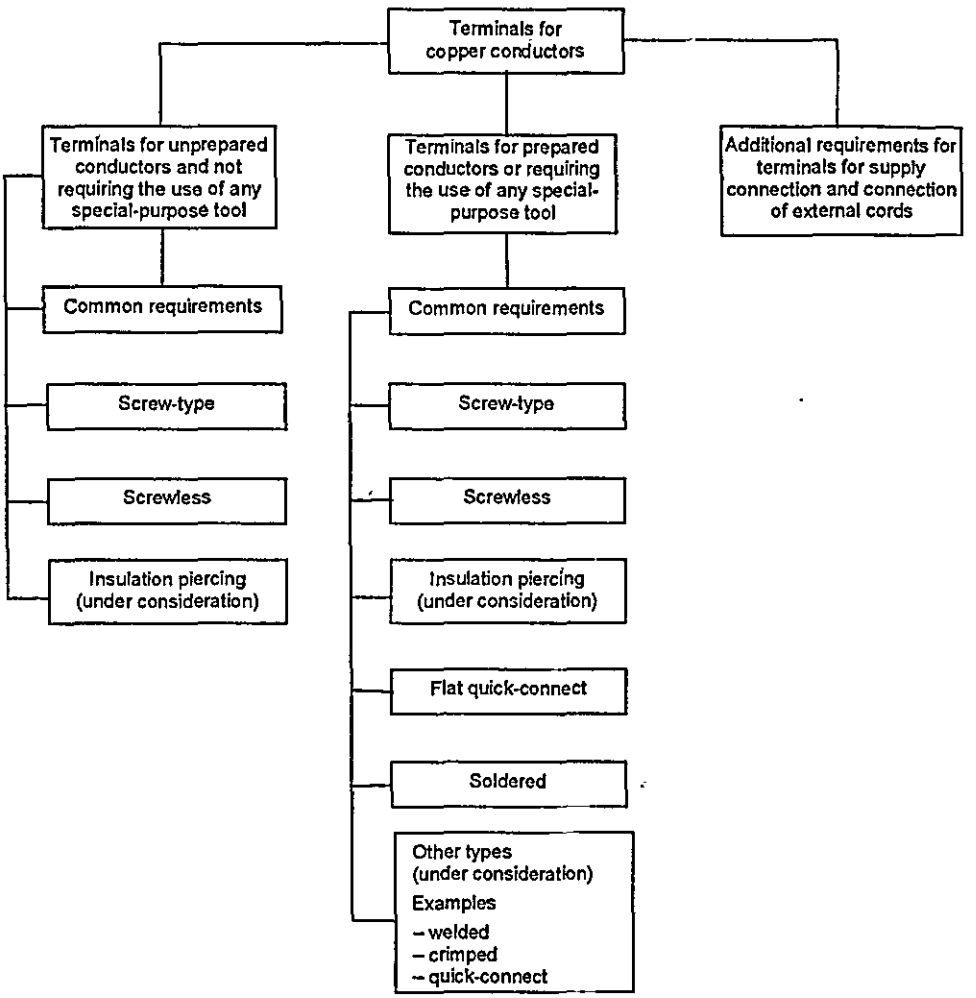
F.1.2.1 Switches having both resistive and motor load ratings are not suitable for switching a combined load of the full resistive load plus the full motor load. Such switches can be used for switching a combined resistive load plus a motor load, providing the vector sum of the resistive current and six times the steady-state motor current does not exceed either the resistive current rating or six times the motor current rating, whichever is greater, and depending upon the power factor of the combined load. The vector sum of the resistive current and the steady-state current of the motor shall not exceed the resistive current rating.

NOTE An example is a switch in which the same set of contacts is used to control a circuit in a fan heater which incorporates both a heating element and a motor.

F.1.2.2 Switches having both resistive and motor load ratings may be used for tungsten filament lamp loads, provided that the steady-state lamp load current does not exceed either 10 % of the resistive current rating or 60 % of the motor current rating, whichever is greater.

Annex G
(informative)

Schematic diagram of families of terminals



Annex H
(informative)

Flat quick-connect terminations, method for selection of female connectors

For the purpose of testing switches with tabs, approved female connectors with dimensions according to IEC 60760 shall be used.

In case of doubt, female connectors according to figure 8 are submitted to the following tests. If the tests are withstood, new specimens of the same production lot are used for the purpose of testing switches.

Six specimens of the female connectors are fitted with conductors of the medium cross-sectional area specified in table 4. For each female connector an unused tab is inserted and then withdrawn. The same tab is inserted and withdrawn five times more. The insertion force and the withdrawal force are applied axially and without jerks, they are measured for each insertion and each withdrawal.

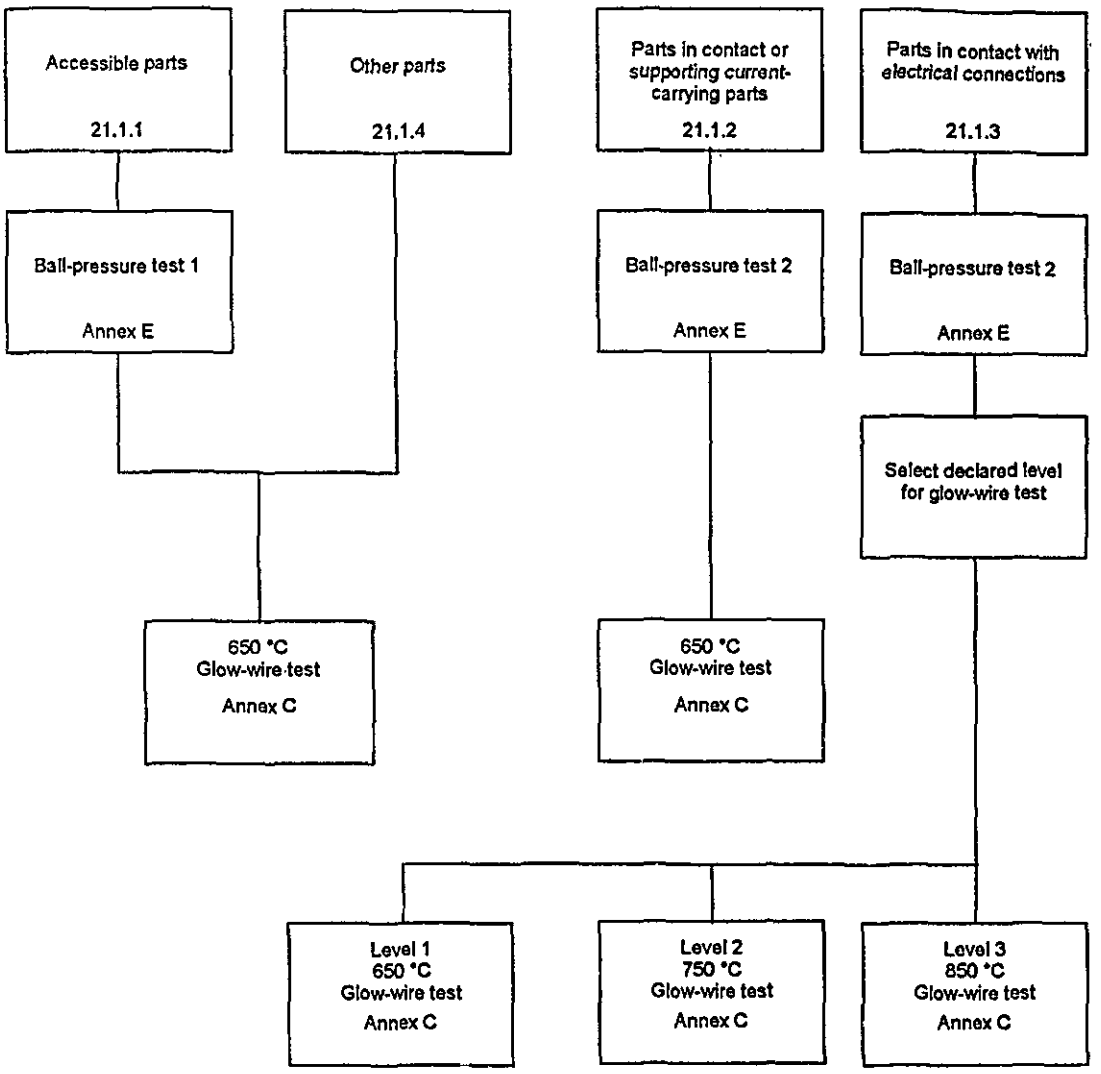
The insertion and withdrawal forces shall be within the limits according to table H.1

Table H.1 – Insertion and withdrawal forces for flat quick-connect terminations

Tab size	First insertion	First withdrawal			Sixth withdrawal	
	Maximum individual force	Maximum force	Minimum force		Minimum force	
			Average	Individual	Average	Individual
mm	N	N	N	N	N	N
Unplated brass tab and unplated brass female connector						
2,8	53	44	13	9	9	5
4,8	67	89	22	13	13	9
6,3	80	80	27	18	22	18
9,5	100	80	30	20	30	20
Unplated brass tab and tin plated female connector						
2,8	53	44	13	9	9	5
4,8	67	89	22	13	13	9
6,3	76	76	22	13	18	13
9,5	100	80	40	23	40	23

Annex J
(*informative*)

Selection and sequence of tests of clause 21



Annex K
(normative)

Relation between rated impulse withstand voltage, *rated voltage and overvoltage category*

Table K.1 – Rated impulse withstand voltage for switches energized directly from the low voltage mains

Nominal voltage of the supply system based on IEC 60038[1] V		Voltage line to neutral derived from nominal voltages a.c. or d.c. up to including V	Rated impulse withstand voltage[2] [3] kV		
Three-phase	Single-phase		Overvoltage category		
			I	II	III
		50	0,33	0,5	0,8
		100	0,5	0 8	1 5
		150	0.8	1.5	2,5
230/400, 277/480	120-240	300	1,5	2,5	4,0

NOTE 1 For more detailed information, see IEC 60664-1 For example, for the overvoltage category, see 2 2 2 1 1

NOTE 2 In general, switches for appliances are *considered to fall within overvoltage category II Overvoltage* category I is applicable if special precautions against transient overvoltage are built into the appliance

1) The / mark indicates a four-wire three-phase distribution system The lower value is the voltage line-to-neutral while the higher value is the voltage line-to-line

2) Switches with these rated impulse withstand voltages can be used in installations in accordance with IEC 60364-4-443

3) For switches capable of generating an overvoltage at the switch terminals, the rated impulse withstand voltage implies that the switch shall not generate overvoltage in excess of this value when used in accordance with the *relevant appliance standard* and instructions of the manufacturer.

Annex C
(normative)

Glow-wire test

The glow-wire test is made in accordance with IEC 60695-2-1.

For the purpose of this standard, the following applies

a) *In clause 4 description of test apparatus, the first paragraph on page 11 is replaced by*

"In cases where burning or glowing particles might fall from the test specimen onto an external surface underneath, the test is carried out with a piece of white pine-wood board approximately 10 mm thick and covered with a single layer of tissue paper, positioned at a distance of 200 mm ± 5 mm below the place where the tip of the glow-wire is applied to the specimen When the specimen is a complete switch, the switch itself, in its normal position of use, is placed on, or mounted above, the pine-wood board covered with a single layer of tissue paper Before starting the test, the board is conditioned as described in clause 7 for the specimen "

b) *In clause 5, severities, the duration of application of the tip of the glow-wire to the specimen is 30 s ± 1 s*

c) *In clause 10 observations and measurements, items b) and c) shall be recorded and reported*

In cases where it is neither practical nor possible to carry out the test on a complete switch due to metallic parts preventing full penetration of the glow-wire, the test is carried out after having removed the metal parts preventing the full penetration of the glow-wire

When the switch is either too small or of an inconvenient shape to carry out the test, the test is carried out using a specimen of the material from which the component is manufactured The specimen shall be of the smallest size possible, resembling the original in size and thickness and, in any case, shall be not greater than 25 mm in diameter and 3 mm thick

The test is not carried out on parts that are too small to contribute appreciably to a fire hazard

Annex M
(normative)

Impulse voltage test

The purpose of this test is to verify that clearances will withstand specified transient overvoltage. The impulse withstand voltage test is carried out with a voltage having a 1,2/50 µs wave form as specified in IEC 60060-1 and is intended to simulate overvoltage of atmospheric origin. It also covers overvoltages due to switching of low-voltage equipment.

The test shall be conducted for a minimum of three impulses of each polarity with an interval of at least 1 s between pulses.

NOTE The output impedance of the impulse generator should not be higher than 500 Ω. When testing specimens incorporating components across the test circuit, a much lower output impedance may be used.

When surge suppression is provided inside the specimen, the impulse shall have the following characteristics.

- the waveform 1,2/50 µs for the no-load voltage with amplitudes equal to the values in table M 1,
- the waveform 8/20 µs for an appropriate surge current.

NOTE The voltage waveform of the test voltage source is applicable whether or not the specimen is equipped with surge suppression. If the specimen is provided with surge suppression, the impulse voltage wave may be chopped but the specimen should be in a condition to operate normally again after the test.

If the specimen is not provided with surge suppression and it withstands the impulse voltage, the waveform will not be noticeably distorted.

Table M.1 – Test voltages for verifying clearances at sea-level

Rated impulse withstand voltage $\hat{U}$ kV	Impulse test voltage at sea-level $\hat{U}$ kV
0,33	0,35
0,5	0,55
0,8	0,91
1,5	1,75
2,5	2,95
4,0	4,8
6,0	7,3

NOTE 1 When testing clearances, associated solid insulation will be subjected to the test voltage. As the impulse test voltage of table M.1 is increased with respect to the rated impulse withstand voltage, solid insulation will have to be designed accordingly. This results in an increased impulse withstand capability of the solid insulation.

NOTE 2 The test may be made with the pressure adjusted to the value corresponding to the altitude of 2 000 m (80 kPa) and 20 °C with the test voltage corresponding to the rated impulse withstand voltage. In this case, solid insulation will not be subjected to the same withstand requirements as when testing at sea-level.

NOTE 3 Explanations concerning the influencing factors (air pressure, altitude, temperature, humidity) with respect to dielectric strength of clearances are given in 4.1 1 2 1.2 of IEC 60664-1.

Annex N
(normative)

Altitude correction factors

As the dimensions given in table 22 are valid for altitudes up to and including 2 000 m above sea-level, clearances for altitudes above 2 000 m shall be multiplied by the altitude correction factor specified as follows.

Table N.1 – Altitude correction factors

Altitude m	Normal barometric pressure kPa	Multiplication factor for clearances
2 000	80,0	1,00
3 000	70,0	1,14
4 000	62,0	1,29
5 000	54,0	1,48
6 000	47,0	1,70
7 000	41,0	1,95
8 000	35,5	2,25
9 000	30,5	2,62
10 000	26,5	3,02
15 000	12,0	6,67
20 000	5,5	14,50

F.1.2.3 Switches with motor current ratings only may either be classified

- according to 7.1 2 2 by declaring the resistive load to be equal to the motor load, or
- according to 7 1 2.5 for a declared specific load.

F.1.3 Combination capacitive and resistive load ratings

NOTE An example is a circuit in a radio-receiving apparatus for sound and television.

F.1.4 Declared specific load ratings

NOTE 1 Examples are fluorescent lamp loads and inductive loads with a power factor less than 0,6.

NOTE 2 Switches submitted in an appliance may be tested using the circuit in the appliance and classified according to 7 1 2 5 as a declared specific load.

F.1.5 Current ratings not exceeding 20 mA

NOTE Examples are switches which control discharge lamp indicators and other signal lamps.

Annex P
(normative)

Types of coatings for rigid printed board assemblies

Type A coating: Provides only protection against pollution by improving the environment for spacings between printed wiring conductors under the coating to pollution degree 1. The clearance and creepage distance requirements of 20 1 and 20.2 apply to the rigid printed board assembly under the coating

Type B coating: Provides protection against pollution and insulation by enclosing the conductors in solid insulation so that the clearance and creepage distance requirements of 20 1 and 20.2 are not applicable between conductors under the coating

NOTE 1 Coating can be effective between two conducting parts if it covers either one or both conductive parts together with at least 80 % of the creepage distance between them As a result, some coated rigid printed board assemblies can be used with higher voltage or reduced clearances and creepage distances between conductive parts compared to the same rigid printed board assembly when uncoated

NOTE 2 Clearance and creepage distance requirements according to 20 1 and 20.2 apply to all uncoated parts of the rigid printed board assembly and between conductive parts over the coating

Annex R
(normative)

Routine tests

R.1 Introduction

Normative routine tests are prescribed in those situations where detection on a 100 % basis is considered to be essential for safety

R.2 General considerations

In cases where the switch does not pass the relevant tests, corrective actions shall be made.

R.3 Routine tests to be conducted in the situation of reduced clearances

Clearances for basic or functional insulation which are less than the values given in table 22 shall be confirmed by routine test, using the test of annex M

R.4 Routine tests to be conducted on cord switches and independently mounted switches

The following tests shall be conducted on cord switches (IEC 61058-2-1) and independently mounted switches (IEC 61058-2-4)

- earthing continuity is tested according to 10.4 but with a test current not less than 10 A The test is conducted for the duration needed for the measurement to be made;
- for non-rewirable switches with moulded-on flexible cables a dielectric strength test according to clause 15, without humidity treatment This test is applied between accessible metal parts of the switch and live parts of the switch The test is conducted for 1 s at the value specified in table 12

Annex S
(informative)

Sampling tests

S.1 Introduction

Annex S is provided for guidance as a means to confirm that products manufactured after type testing to this standard continue to perform in the declared manner. Test plans other than as described in this annex may be used if determined to satisfy the same purpose.

S.2 General considerations

Tests specified in this annex may be considered as part of a product examination test plan. The product examination is applied during ongoing production of the switch.

In cases where the switch does not pass the relevant tests, corrective action should be taken.

Tests according to S.3 are conducted on samples taken randomly from the production line, in accordance with written procedures. The need, nature and frequency of the tests and the sampling rates used for these tests may be influenced by:

- the construction of the product;
- the quality control system used, and,
- the quantity of products manufactured.

Tests may be carried out with different test methods than those applied in conjunction with the type tests if the alternate test methods can be shown to be equivalent.

The quality control system used should include the elements of an ISO 9000 quality control system which apply to manufacturing and production systems. The requirements of the quality control system may be met by other means.

S.3 Tests

S.3.1 The following tests apply as part of a sampling plan on all production, independently of switch types or switch groupings.

- Check of content of marking according to clause 8, and durability of marking according to 8.9.

  NOTE The test may be omitted when ongoing conformity is found (e.g., by use of moulding, etching or similar processes).

- Dielectric strength test according to clause 15 without humidity treatment.

  NOTE The test may be omitted when ongoing conformity is found (e.g. by design).

S.3.2 Within a time period specified in written procedures, the following tests should be conducted in the order given:

- dielectric strength test according to clause 15;
- heating test on contacts and terminals according to 16.2;
- endurance test according to clause 17.

The tests should be conducted on individual switch types, which may be selected from switch families, according to annex T The number of test samples is according to table 1 of this standard They may be grouped into switch families according to annex T, and the tests may then be carried out with samples selected according to annex T. Annex T gives an example system for grouping switch types into switch families for this purpose Other grouping systems may also be appropriate for this purpose.

S.3.3 Within a time period specified in written procedures, glow wire tests and ball pressure tests according to clause 21, and proof tracking tests according to annex D, should be conducted on samples of material representing the different switch constructions and materials in production. However, these tests do not apply if it is otherwise verified that the same raw materials, moulds and processes are used as for the type test. This may be accomplished as part of a moulder's verification program These tests may be part of incoming inspection rather than as part of production testing

Annex T
(informative)

Switch families

T.1 Introduction

Annex T gives an example system for grouping switch types into switch families, as relates to tests specified in S.3.2. Other grouping systems may be appropriate for this purpose. As used in this annex, a "switch family" refers to a single grouping of different switch types that are representative of one another in construction and performance.

T.2 General

Switch types may be grouped into switch families in such a way that the most severe case for the switch family can be represented by the tests each time the tests are conducted.

Alternatively, when switch families include switch types with different ratings, the switches should be selected for test in proportion to production volume, and, the severest rating of the selected switch type should be tested each time.

A switch family may include the following variations:

- different electrical ratings for switches that employ
  - the same basic contact construction, except for the diameter, thickness or material of the contacts;
  - the same configuration of internal contacts, base and actuator; and
  - the same number of poles;
- different external parts such as terminals and actuating members;
- one-way, two-way, and multiway types;
- normally open and normally closed biased types of switches;
- different contact constructions under the following conditions: switches with the same or with different electrical ratings that employ the same basic contact construction, except for the diameter, thickness, or material of the contacts, may be included in the same switch family, provided the switches have the same configuration of internal contacts, base and actuator, and the same number of poles;
- single-pole, double-pole, and multiple-pole types when the electrical rating is the same and there is a similar configuration of internal contacts, base and actuator;
- different combinations of electrical rating, temperature and number of operating cycles within identical constructions.

T.3 Guidelines for selection of switches in switch families for testing

T.3.1 One-way / two-way or biased switches in same switch family selection should be made on an as-available basis

T.3.2 Different number of poles in same switch family, selection should be rotated in proportion to production volume

T.3.3 Different operating cycle ratings for the same electrical rating within identical constructions and different combinations of electrical, temperature and operating cycle ratings: rotate selection in proportion to relative production volume of each type

T.3.4 Same contacts but different electrical ratings in same switch family: if the switch family includes various ratings, rotate selection in proportion to relative production volume of each type The endurance test should be conducted at the maximum volt-ampere rating at the highest voltage applicable to the selected switch type and the heating test should be conducted at the highest current rating applicable to the selected switch type

T.3.5 Different contacts and different ratings in same switch family selection of switch types for test should be rotated based on production volume of each contact type used. The endurance test should be conducted at the maximum volt-ampere rating at the highest applicable voltage applicable to the selected contact each time. The heating test should be conducted at the highest applicable current rating applicable to the selected contact type each time

T.3.6 Co-ordinated electrical ratings (i e , same volt-ampere ratings with different voltage and ampere ratings) in same switch family selection should be rotated on the basis of production volume, considering maximum ratings in the switch family as specified in T 3 4

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19.2.8 Screws and nuts for clamping the conductors shall have a metric ISO thread or a thread comparable in pitch and mechanical strength.

Compliance is checked by inspection and by the tests of 19.2.

Provisionally, SI, BA and UN threads are considered to be comparable in pitch and mechanical strength to metric ISO thread.

19.3 Current-carrying parts

Current-carrying parts and parts in an earthing path shall be of a metal having, under conditions occurring in the switch, adequate mechanical strength and resistance to corrosion

Springs, resilient parts, clamping screws and the like of terminals are not considered as parts mainly intended for carrying current

Examples of metals resistant to corrosion when used within the permissible temperature range and under normal conditions of chemical pollution, are

- copper;
- an alloy containing at least 58 % copper for parts that are worked cold or at least 50 % copper for other parts;
- stainless steel containing at least 13 % chromium and not more than 0,09 % carbon,
- steel provided with an electroplated coating of zinc according to ISO 2081, the coating having a thickness of at least
  - 5 µm ISO service condition No 1, for non-protected switches;
  - 12 µm ISO service condition No. 2, for switches with degree of protection IPX1 through IPX4;
  - 25 µm ISO service condition No. 3, for switches with degree of protection IPX5 through IPX7;
- steel provided with an electroplated coating of nickel and chromium according to ISO 1456, the coating having a thickness of at least
  - 20 µm ISO service condition No. 2, for non-protected switches;
  - 30 µm ISO service condition No. 3, for switches with degree of protection IPX1 through IPX4;
  - 40 µm ISO service condition No. 4, for switches with degree of protection IPX5 through IPX7,
- steel provided with an electroplated coating of tin according to ISO 2093, the coating having a thickness of at least
  - 12 µm ISO service condition No. 2, for non-protected switches;
  - 20 µm ISO service condition No. 3, for switches with degree of protection IPX1 through IPX4;
  - 30 µm ISO service condition No. 4, for switches with degree of protection IPX5 through IPX7.

Parts which might be subjected to arcs and mechanical wear shall not be made of steel provided with an electroplated coating.

Compliance is checked by inspection and if necessary by chemical analysis.

NOTE 1 This requirement does not apply to switching and sliding contacts.

NOTE 2 This requirement does not apply to current-carrying parts which carry a current equal to or less than 20 mA.

20 Clearances, creepage distances, solid insulation and coatings of rigid printed board assemblies

Switches shall be constructed so that the clearances, creepage distances, solid insulation and coatings of rigid printed board assemblies are adequate to withstand the electrical, mechanical and thermal stresses taking into account the environmental influences that may occur during the anticipated life of the switch.

Clearances, creepage distances, solid insulation and coatings of rigid printed board assemblies shall comply with the relevant subclauses 20.1 to 20.4.

NOTE The requirements and tests are based on IEC 60664-1 and IEC 60664-3.

20.1 Clearances

The clearances shall be dimensioned to withstand the rated impulse voltage declared by the manufacturer according to 7.1.10, considering the rated voltage and the overvoltage category as given in annex K and the pollution degree declared by the manufacturer according to 7.1.6.

For the measurements:

- *Detachable parts are removed and movable parts which can be assembled in different orientations placed in the most unfavourable position.*

  NOTE 1 Movable parts are for example hexagonal nuts, the position of which cannot be controlled throughout an assembly.

- *Distances through slots or openings in surfaces of insulating material are measured to a metal foil in contact with the surface. The foil is pushed into corners and the like by means of the standard test finger of IEC 60529, but is not pressed into openings.*

- *A force is applied to bare conductors and accessible surfaces in order to attempt to reduce clearances when making the measurement.*

  The force is:

  - *2 N for bare conductors;*
  - *30 N for accessible surfaces.*

  The force is applied by means of a straight unjointed test finger of the same dimensions as the jointed test finger shown in figure 1 of IEC 60529.

  When applied to openings as specified in 9.1, the distance through insulation between live parts and the metal foil shall not be reduced below the values specified.

NOTE 2 For the measurement of clearances and creepage distances, see annex A.

NOTE 3 A flow chart for the dimensioning of clearances is given in annex B.

20.1.1 Clearances for basic insulation

The clearances for basic insulation shall not be less than the values given in table 22.

However, smaller clearances, except those values marked in table 22 with note 5, may be used if the switch meets the impulse withstand voltage test of annex M but only if the parts are rigid or located by mouldings or if the construction is such that there is no likelihood of the distances being reduced by distortion, or by movement of the parts during mounting, connection and normal use

Compliance is checked by measurement and, if necessary by the test of annex M.

20.1.2 Clearances for functional insulation

The clearances for functional insulation shall not be less than the values specified for basic insulation in 20 1 1

Compliance is checked by measurement and, if necessary, by the test of annex M

20.1.3 Clearances for supplementary insulation

The clearances for supplementary insulation shall not be less than the values given in table 22

Compliance is checked by measurement

Table 22 – Minimum clearances for basic insulation

Rated impulse withstand voltage [2] kV	Minimum clearances in air in millimetres up to 2 000 m above sea-level [1] [7] [3]		
	Pollution degree 1	Pollution degree 2	Pollution degree 3
0,33	0,01	0,2 [4] [5]	0,8 [5]
0,50	0,04	0,2 [4] [5]	0,8 [5]
0,80	0,10	0,2 [4] [5]	0,8 [5]
1,5	0,5	0,5	0,8 [5]
2,5	1,5	1,5	1,5
4,0	3	3	3
6 [6]	5,5	5,5	5,5

[1] Clearances for altitudes above 2 000 m sea-level shall be multiplied by the altitude correction factor specified in annex N.

[2] This voltage is:

- for functional insulation: the maximum impulse voltage expected to occur across the clearance;
- for basic insulation directly exposed to or significantly influenced by transient overvoltage from the low-voltage mains: the rated impulse withstand voltage of the switch;
- for other basic insulation: the highest impulse voltage that can occur in the circuit.

[3] Details for pollution degree are given in annex L.

[4] For printed wiring material, the values for pollution degree 1 apply, except that the value shall not be less than 0,04 mm.

[5] Minimum clearance values based on experience rather than on fundamental data.

[6] This voltage is only applicable when determining reinforced insulation for a rated impulse withstand voltage of 4,0 kV.

[7] The values for clearances on rigid printed boards do not apply under the provision that the requirements of clause 23 are fulfilled and that the overcurrent protection provides full disconnection.

NOTE The values given in table 22 are equal to IEC 60664-1 and are not increased because only minimal reduction of clearances, for example, due to mechanical abrasion during the lifetime of the switch, is expected and because of the, in general, small overall dimension of switches for appliances.

20.1.4 Clearances for reinforced insulation

The clearances for reinforced insulation shall be not less than the values specified for basic insulation in 20.1.1 but using the next higher step for the rated impulse withstand voltage in table 22. Smaller clearances than those specified in table 22 are not allowed.

Compliance is checked by measurement.

20.1.5 Clearances for disconnection

20.1.5.1 Electronic disconnection

No clearances are specified for electronic disconnection.

20.1.5.2 Micro-disconnection

Clearances between terminals and terminations shall fulfil the requirement for functiona insulation according to 20 1 2.

No clearances are specified for the distance across the contacts

Clearances between other current-carrying parts which are separated by the action of the switch shall be equal to or greater than the actual value of the distance between the relevant contacts They shall, however, be at least 0,5 mm for switches with a rated impulse withstanc voltage of ≥1,5 kV

NOTE The values for clearances on rigid printed boards do not apply under the provision that the requirements of clause 23 are fulfilled and that the overcurrent protection provides full disconnection.

20.1.5.3 Full disconnection

The clearances for full disconnection shall not be less than the values for basic insulation specified in 20 1 1 except that smaller values than those given in table 22 are not allowed

In switches where clearances in any one pole between parts separated by the action of the switch is provided by two or more breaks in series the separation is considered to be the sum of the distances of the breaks. Each break shall be not less than one-third of the prescribed distance

20.2 Creepage distances

The creepage distances shall be dimensioned for the voltage which is expected to occur in normal use taking into account the pollution degree as declared by the manufacturer according to 7 1 6 and the material group

For the measurements

- *Detachable parts are removed and movable parts and parts which can be assembled in different orientations placed in the most unfavourable position*

  NOTE 1 Movable parts are, for example hexagonal nuts, the position of which cannot be controlled throughout an assembly.

- *Distances through slots or openings in surfaces of insulating material are measured to a metal foil in contact with the surface The foil is pushed into corners and the like by means of the standard test finger of IEC 60529, but is not pressed into openings*

- *A force is applied to bare conductors and accessible surfaces in order to attempt to reduce creepage distances when making the measurement*

  The force is

  - *2 N for bare conductors,*
  - *30 N for accessible surfaces.*

  The force is applied by means of a straight unjointed test finger of the same dimensions as the jointed test finger shown in figure 1 of IEC 60529

  NOTE 2 For the measurements of creepage distances, see annex A

  NOTE 3 A flow chart for the dimensioning of creepage distances is given in annex B

  NOTE 4 A creepage distance cannot be less than the associated clearance.

The relationship between material group and proof tracking index (PTI) values is as follows:

Material group I	600	≤	PTI		
Material group II	400	≤	PTI	<	600
Material group IIIa	175	≤	PTI	<	400
Material group IIIb	100	≤	PTI	<	175

These PTI values are obtained in accordance with the proof tracking test of annex D.

NOTE 5 Attention is drawn to the fact that certain IEC 60335-2 parts require a minimum PTI value of 250.

NOTE 6 For glass, ceramics and other inorganic materials which do not track, creepage distances need not be greater than their associated clearance.

20.2.1 Creepage distances for basic insulation

The creepage distances for basic insulation shall not be less than the values given in table 23.

Compliance is checked by measurement.

Table 23 – Minimum creepage distances for basic insulation

Rated voltage r.m.s.[1]	Creepage distance in millimetres[4) 2)]						
	Pollution degree 1	Pollution degree 2			Pollution degree 3		
		Material group			Material group		
V		I	II	IIIa/IIIb	I	II	IIIa
50[3)]	0,2	0,6	0,9	1,2	1,5	1,7	1,9
125	0,3	0,8	1,1	1,5	1,9	2,1	2,4
250	0,6	1,3	1,8	2,5	3,2	3,6	4,0
400	1,0	2,0	2,8	4,0	5,0	5,6	6,3
500	1,3	2,5	3,6	5,0	6,3	7,1	8,0

1) This voltage is the voltage rationalized through table 3a and table 3b of IEC 60664-1 based on the rated voltage.

2) Details for pollution degrees are given in annex L.

3) Concerning SELV, the last paragraph of 9.1 should be considered.

4) The values for creepage distances on rigid printed boards do not apply under the provision that the requirements of clause 23 are fulfilled and that the overcurrent protection provides full disconnection.

20.2.2 Creepage distances for functional insulation

The creepage distances for functional insulation shall not be less than the values given in table 24.

Compliance is checked by measurement.

Table 24 - Minimum creepage distances for functional insulation

Working voltage r.m.s. [1]	Printed board assemblies		Pollution degree [2] [6]						
	Pollution degree								
	1 [3]	2 [4]	1 [3]	2			3		
				Material group			Material group		
V				I	II	III [5]	I	II	III [5]
	mm	mm	mm	mm	mm	mm	mm	mm	mm
10	0 025	0,04	0,08	0 4	0,4	0,4	0,95	0 95	0 95
12,5	0 025	0,04	0 09	0,42	0 42	0 42	1 0	1,0	1,0
16	0,025	0,04	0,1	0,45	0,45	0,45	1,05	1.05	1 05
20	0,025	0,04	0,11	0,48	0,48	0,48	1,1	1,1	1 1
25	0,025	0,04	0,125	0,5	0,5	0,5	1,2	1,2	1,2
32	0 025	0,04	0,14	0 53	0,53	0,53	1,25	1 25	1 25
40	0 025	0 04	0,16	0,56	0,8	1 1	1 3	1 3	1,3
50	0 025	0 04	0,18	0,6	0,85	1 2	1,4	1,6	1,8
63	0,04	0,063	0,2	0,63	0 9	1 25	1,5	1,7	1,9
80	0 063	0,1	0,22	0,67	0,95	1,3	1,6	1,8	2 0
100	0 1	0 16	0,25	0,74	1	1,4	1,7	1,9	2,1
125	0,16	0,25	0,28	0 75	1,05	1 5	1,8	2,0	2,2
160	0,25	0,4	0,32	0 8	1,1	1,6	1 9	2,1	2,4
200	0,4	0,63	0,42	1	1,4	2	2,0	2,2	2,5
250	0,56	1	0,56	1,25	1 8	2,5	2,5	2,8	3,2
320	0,75	1,6	0,75	1 6	2,2	3 2	3,2	3,6	4,0
400	1	2	1	2	2 8	4	4,0	4,5	5,0
500	1,3	2,5	1,3	2 5	3,6	5	5,0	5 6	6,3
630	1 8	3,2	1,8	3,2	4 5	6,3	6,3	7,1	8
800	2,4	4	2,4	4	5,6	8	8	9	10
1 000	3,2	5	3,2	5	7,1	10	10	11	12,5

1) Interpolation for intermediate values is allowed

2) Details for pollution degrees are given in annex L

3) Material groups I, II, IIIa and IIIb

4) Material group I, II, IIIa

5) Material groups III includes IIIa, and IIIb

6) The values for creepage distances on rigid printed boards do not apply under the provision that the requirements of clause 23 are fulfilled and that the overcurrent protection provides full disconnection

20.2.3 Creepage distances for supplementary insulation

The creepage distances for supplementary insulation shall not be less than the values specified for basic insulation in 20.2.1.

Compliance is checked by measurement.

20.2.4 Creepage distances for reinforced insulation

The creepage distances for reinforced insulation shall not be less than double the values specified for basic insulation in 20.2.1.

Compliance is checked by measurement.

20.2.5 Creepage distances for disconnection

The creepage distances for disconnection shall not be less than the values specified for functional insulation in 20.2.2.

Compliance is checked by measurement.

NOTE 1 For conductive pollution, see annex L, last paragraph.

NOTE 2 The values for creepage distances on rigid printed boards do not apply under the provision that the requirements of clause 23 are fulfilled and that the overcurrent protection provides full disconnection.

20.3 Solid insulation

Solid insulation shall be capable of durably withstanding electrical and mechanical stresses as well as thermal and environmental influences which may occur during the anticipated life of the switch.

Compliance is checked during the tests of clauses 14, 15, 16 and 17.

The distance through accessible supplementary solid insulation shall have a minimum value of 0,8 mm.

The distances through accessible reinforced solid insulation shall have the following minimum values:

– for rated impulse withstand voltage equal to or less	1 500 V:	0,8 mm;
– for rated impulse withstand voltage equal to or larger	2 500 V:	1,5 mm.

NOTE 1 The values take into consideration the possibility of cracks as a single fault occurring in the solid insulation. The values corresponding to basic insulation are taken from table 22, considering pollution degree 3.

NOTE 2 No minimum thickness is specified for functional, basic, inaccessible supplementary and inaccessible reinforced insulation.

Compliance is checked by inspection and by measurement.

NOTE 3 An abrasion test for accessible insulation is under consideration.

20.4 Coatings of rigid printed board assemblies

Coatings of rigid printed board assemblies shall provide protection against pollution and/or insulation depending on the type A or type B coating used.

NOTE Explanations for type A and type B coating are given in annex P.

20.4.1 Type A coating

The insulation distances of a rigid printed board assembly with type A coating, as declared by the manufacturer, shall comply with the highest value for pollution degree 1 of the clearances given in table 22 and of the creepage distances given in table 24

Compliance is checked by measurement and for the type A coating by the relevant tests of clause 6 of IEC 60664-3 with the test levels or conditions as given in table 25.

NOTE Details for the measuring of the insulation distance of a coated printed board are given in annex Q

Table 25 – Test levels and conditions

IEC 60664-3 subclause	Test levels and conditions
6 6.1 Cold storage	–25 °C
6 6.3 Rapid change of temperature	Degree of severity 2 (–25 °C to 125 °C)
6 7 Electromigration	Not applicable
6 8 6 Partial discharge	Not applicable

Test specimens can be

- standard test specimens as specified in 5 1 and 5 2 of IEC 60664-3, or
- any representative rigid printed board assemblies as specified in 5 3 of IEC 60664-3

20.4.2 Type B coating

A rigid printed board assembly with type B coating as declared by the manufacturer shall comply with the requirements for solid insulation as specified in 20 3 No clearances and creepage distances are specified between conductors on printed boards under the coating

Compliance for the type B coating is checked by the relevant test of clause 6 of IEC 60664-3 with the test levels or conditions as given in table 25 and the test specimens as specified in 20.4 1

21 Resistance to heat and fire

21.1 Resistance to heat and fire

NOTE Annex J may be used as a guideline to select the sequences and tests of this clause

Parts of non-metallic material (except parts unlikely to be ignited or to propagate flames originating from the switch, for which no test is required) shall be resistant to heat and fire

Compliance is checked by the tests of 21 1.1, 21.1.2, 21 1 3 and 21 1 4.

21.1.1 *For parts which are accessible when the switch is mounted as declared, and the deterioration of which may result in the switch becoming unsafe:*

- *the ball-pressure test 1 of annex E followed by the glow-wire test of annex C carried out at the 650 °C level.*